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## *THE RELATIONSHIPS AND RESPONSIBILITIES OF MUSEUMS.**

IN an article on 'The use and abuse of Museums,' written nearly fifteen years ago by Professor William Stanley Jevons, attention was directed to the circumstance that there was not, at that time, in the English language a treatise analyzing the purposes and kinds of museums, and discussing the general principles of their management and economy. It is somewhat surprising that the need then made so evident has not since been supplied and that there is not at the present day such a treatise in the English or any other language. Many important papers have in the interval been printed in regard to particular classes of museums and special branches of museum work. Notable among these have been those written by Sir William H. Flower, Professor W. A. Herdman, Dr. J. S. Billings, Dr. H. H. Higgins, Dr. Albert Günther and General Pitt Rivers, and there had previously been printed the well known essay of Dr. J. E. Gray, Edward Forbes' suggestive paper on 'Educational Uses of Museums,' in 1853, and the still earlier one by Edward Edwards on 'The Maintenance and Management of Public Galleries and Museums,' printed in 1840.

No one has as yet attempted, however, even in a preliminary way, to formulate a general theory of administration applicable to museum work in all its branches, except Professor Jevons, who, in the paper already referred to, presented in an exceedingly impressive manner certain ideas which should underlie such a theory.

* Part of a paper on 'The Principles of Museum Administration,' read before the *Museums Association*, at Newcastle-on-Tyne, July 23, 1895.

It is still true, as it was when Professor Jevons wrote, in 1881, that there is not in existence 'a treatise analyzing the purposes and kinds of museums and discussing the general principles of their management and economy.' With this fact in mind I have ventured to begin the preparation of such a treatise and to attempt to bring together in one systematic sequence the principles which I believe to underlie the practice of the wisest and most experienced of modern museum administrators.

My ideas are presented, it may be, in a somewhat dogmatic manner, often in the form of aphorisms, and to the experienced museum worker many of them will, perhaps, sound like truisms.

I have had two objects in view:

It has been my desire, in the first place, to begin the codification of the accepted principles of museum administration, hoping that the outline which is here presented may serve as the foundation for a complete statement of those principles, such as can only be prepared through the coöperation of many minds. With this in view, it is hoped that the paper may be the cause of much critical discussion.

My other purpose has been to set forth the aims and ambitions of modern museum practice, in such a manner that they shall be intelligible to the persons who are responsible for the establishment of museums and also to the directors of other public institutions founded for similar purposes, in order to evoke more fully their sympathy and coöperation.

Museums of art and history, as well as those of science, are discussed in this paper, since the same general principles appear to be applicable to all.

The theses proposed are two hundred and fifteen in number and are arranged under the following heads or chapters:

I. The Museum and its Relationship; II. The Responsibilities and Requirements of Museums; III. The Five Cardinal Necessities in Museum Administration; IV. The Classification of Museums; V. The Uses of Specimens and Collections; VI. The Preservation and Preparation of Museum Materials; VII. The Art of Installation; VIII. Records, Catalogues and Specimen Labels; IX. Exhibition Labels and Their Function; X. Guides and Lecturers; Hand Books and Reference-books; XI. The Future of Museum Work.

[The introductory portion, consisting of the first three chapters, and the last chapter are here printed. The remainder of the paper is more technical and is intended especially for the consideration of persons engaged directly in museum work.]

### THE MUSEUM AND ITS RELATIONSHIPS.

A. *The Museum Defined.*

1. A museum is an institution for the preservation of those objects which best illustrate the phenomena of nature and the works of man, and the utilization of these for the increase of knowledge and for the culture and enlightenment of the people.

B. *The Relation of the Museum to other Institutions of Learning.*

1. The Museum in its effort for the increase and diffusion of knowledge aids and is aided by (a) the university and college, (b) the learned society and (c) the public library.

2. The special function of the museum is to preserve and utilize objects of nature and works of art and industry; that of the library to guard the written records of human thought and activity; that of the learned society to discuss facts and theories; that of the school to educate the individual, while all meet together on common ground in the custodianship of learning and in extending the boundaries of existing knowledge.

3. The care and utilization of material objects being the peculiar duty of the mu-

seum, it should not enter the field of other institutions of learning, except to such a degree as may be found absolutely necessary in connection with its own work.

[For example, its library should contain only such books as are necessary for use within its own walls. Its publications should be solely those which are (directly or indirectly) the outgrowth of its own activities. Its teaching work should be such as cannot be performed by other institutions.

On the other hand, schools may advantageously limit their cabinets with reference to the needs of their lecture rooms and laboratories. The library and the learned society should not enter the field of the museum, except in localities where museum agencies are not provided.]

C. *The Relation of the Museum to the Exposition.*

1. The Museum differs from the Exposition both in its aims and in the method of its activity.

2. The Exposition, or Exhibition, and the Fair are primarily for the promotion of industry and commerce; the Museum for the advancement of learning.

3. The principal object of the former is to make known the names of the exhibitors for their own professional or financial advantage; in the latter the name of the exhibitor is incidental, the thing chiefly in mind being the lesson taught by the exhibit.

4. Into the work of the former enters the element of competition, coupled with a system of awards by diplomas or medals; in that of the latter the element of competition does not appear.

5. The educational results of expositions, though undeniably important, are chiefly incidental, and not at all proportionate to to the prodigal expenditure of energy and money which are inseparable from any great exposition.

D. *Museum Features Adopted in Expositions.*

1. Museum methods have been in part adopted by many expositions, in some instances to attract visitors, in others because it has been desired to utilize the occasion to give museum lessons to multitudes to whom museums are not accessible.

2. Those expositions which have been most successful from an educational standpoint have been the ones which have most fully availed themselves of museum methods, notably the London Exhibition of 1851 and the Paris Exposition of 1889.

3. Special or limited exhibitions have a relatively greater educational value, owing to the fact that it is possible in these to apply more fully the methods of the museum. Examples of this principle were afforded by the four expositions held in London from 1883 to 1886—Fisheries, Health, Inventions and Colonial.

4. The annual exhibitions of the academies of art are allied to the exposition rather than to the museum.

5. Many so-called 'museums' are really 'permanent exhibitions,' and many a great collection of pictures can only be suitably described by the name 'picture gallery.'

E. *Temporary Museums.*

1. There are many exhibitions which are administered in accordance with museum principles and which are really temporary museums. To this class belong the best of the loan exhibitions, and also special exhibits made by public institutions, like the 'Luther Memorial Exhibition' of 1874, the material for which was derived chiefly from the Library of the British Museum, and similar exhibitions subsequently held under the same auspices.

F. *Museum Methods in other Institutions—'Museum Extension.'*

1. The zoölogical park, the botanical garden and the aquarium are essentially mu-

seums, and the principles of museum administration are entirely applicable to them.

2. An herbarium in its usual form corresponds to the study series in a museum, and is capable of expansion to the full scope of the general museum.

3. Certain churches and ecclesiastical edifices and classical antiquities in place, when they have been pronounced 'public monuments,' are subject to the principles of museum administration.

4. Many cities, like Rome, Naples, Milan and Florence, by reason of the number of buildings, architectural features, sculpture and other objects in the streets and squares, together with the historical houses duly labeled by tablets, have become practically great museums, and these various objects are administered much in the manner of museums. Indeed, the number of 'Public Monuments' in Italy is so great that the whole country may properly be described as a museum of art and history. A government commission for the preservation of the monuments of history and art regulates the contents of every church, monastery and public edifice, the architectural features of private buildings, and even private collections, to the extent of requiring that nothing shall be removed from the country without governmental sanction. Each Italian town is thus made a museum, and in Rome the site of the Forum and the adjacent ancient structures has been set aside as an outdoor museum under the name of the *Passegiata Archeologica*.

Similar government control of public monuments and works of art exists in Greece and Egypt, and in a lesser degree in the Ottoman Empire, and for half a century there has been a Commission of Historic Monuments in France, which has not only succeeded in protecting the national antiquities, but has published an exceedingly important series of descriptive monographs concerning them.

## THE RESPONSIBILITIES AND REQUIREMENTS OF MUSEUMS.

A. *The Relation of the Museum to the Community.*

1. The museum meets a need which is felt by every intelligent community and furnishes that which cannot be supplied by any other agency. The museum does not exist except among enlightened peoples, and attains its highest development only in great centres of civilization.

2. The museum is more closely in touch with the masses than the university and learned society, and quite as much so as the public library, while, even more than the last, it is a recent outgrowth of modern tendencies of thought. Therefore,

3. THE PUBLIC MUSEUM IS A NECESSITY IN EVERY HIGHLY CIVILIZED COMMUNITY.

B. *The Mutual Responsibilities of the Community and the Museum.*

1. The museums in the midst of a community perform certain functions which are essential to its welfare, and hence arise mutual responsibilities between the community and the museum administrator.

2. The museum administrator must conduct his work with the highest possible degree of efficiency, in order to retain the confidence of the community.

3. The community should provide adequate means for the support of the museum.

4. A failure on the part of the one must inevitably lead to a corresponding failure on the part of the other.

C. *The Specific Responsibilities of the Museum.*

1. The museum should be held responsible for special services, chiefly as follows:

a. *For the advancement of learning.*—To aid learned men in the work of extending the boundaries of knowledge, by affording them the use of material for investigation, laboratories and appliances.

To stimulate original research in connection with its own collections, and to promote the publication of the results.

b. *For record.*—To preserve for future comparative and critical study the material upon which past studies have been made, or which may serve to confirm, correct or modify the results of such studies. Such materials serve to perpetuate the names and identifications used by investigators in their publications and, thus authenticated, to serve as a basis for future investigation in connection with new material. Specimens which thus vouch for the work of investigators are called *Types*. Besides types museums retain for purposes of record many specimens which, though not having served for investigation, are landmarks for past stages in the history of man and nature.

c. *As an adjunct to the class room and the lecture room.* — To aid the teacher either of elementary, secondary, technological or higher knowledge in expounding to his pupils the principles of art, nature and history, and to be used by advanced or professional students in practical laboratory or studio work.

To furnish to the advanced or professional student materials and opportunity for laboratory or studio training.

d. *To impart special information.*—To aid the occasional inquirer, be he a laboring man, school boy, journalist, public speaker or savant, to obtain, without cost, exact information upon any subject related to the specialities of the institution; serving thus as a 'bureau of information.'

e. *For the culture of the public.* To serve the great general public, through the display of attractive exhibition series, well-planned, complete and thoroughly labeled; and thus to stimulate and broaden the minds of those who are not engaged in scholarly research, and draw them to the public library and the lecture room. In this respect the effect of the museum is somewhat analogous to that of travel in distant lands.

2. A museum to be useful and reputable must be constantly engaged in agressive work, either in education or investigation, or in both.

3. A museum which is not agressive in policy and constantly improving cannot retain in its service a competent staff and will surely fall into a decay.

4. A FINISHED MUSEUM IS A DEAD MUSEUM, AND A DEAD MUSEUM IS A USELESS MUSEUM.

5. Many so-called 'museums' are little more than storehouses filled with the materials of which museums are made.

D. *The Responsibility of Museums to Each Other.*

1. There can be no occasion for envious rivalry between museums, even when they are in the same city. Every good museum strengthens its neighbors and the success of the one tends to the popularity and public support of the others.

2. A system of coöperation between museums, by means of which much duplication of work and much expenditure of work may be avoided, is seemingly possible.

3. The first and most important field for mutual understanding is in regard to specialization of plan. If museums in the same town, province or nation would divide the field of work so that each should be recognized as having the first rights in one or more specialities, rivalry would be converted into friendly association and the interests of science and education better served.

4. An important outcome of such a system of coöperation might be the transfer of entire groups of specimens from one museum to another. This would greatly facilitate the work of specialization referred to, and at the same time relieve each museum of the responsibility of maintaining collec-

tions which are not germane to its real purpose. Such transfers have occasionally been made in the past, and there are few museums which might not benefit individually, in a large degree, by a sweeping application of this principle. If its effect upon the effectiveness and interest of any local or national group of museums is taken into account, no one can doubt that the result would be exceedingly beneficial.

5. Another field for coöperation is in joint expenditure of effort and money upon labels and catalogues and in the economical purchase of and in supplies and material.

6. Still another would lie in the coöperative employment of expert curators and preparators, it being thus practicable to pay larger salaries and secure better men.

THE FIVE CARDINAL NECESSITIES IN MUSEUM ADMINISTRATION.

*The Essentials of Success in Museum Work.*

A museum cannot be established and creditably maintained without adequate provision in five directions:

1. A stable organization and adequate means of support.

2. A definite plan, wisely framed in accordance with the opportunities of the institution and the needs of the community for whose benefit it is to be maintained.

3. Material to work upon—good collections or facilities for creating them.

4. Men to do the work—a staff of competent curators.

5. Appliances to work with—a suitable building, with proper accessories, installation material, tools and mechanical assistants.

A. *Stability of Organization.*

1. The only absolute assurance of permanence for a museum lies either in governmental protection, in a connection with some endowed institution of learning, or in special organization with ample endowments.

2. The cabinets of unendowed societies, or those gathered and supported by the efforts of individuals, must in time inevitably be dispersed or destroyed.

B. *Definiteness of Plan.*

1. No two museums can be or ought to be exactly alike. Each should be devoted to one or more special subjects, and should select those subjects not only in reference to opportunity and the needs of the community, but also with regard to the specialties of other museums in the same region, with a view to coöperation.

2. It is the duty of every museum to be preëminent in at least one specialty, be this specialty never so limited.

3. The specialties or departments of any museum may be few or many, but it is important that its plan should be positively defined and limited, since lack of purpose in museum work leads in a most conspicuous way to waste of effort and to failure, partial or complete.

4. It will undoubtedly be found desirable for certain museums, founded for local uses, to specialize mainly in the direction of popular education. If these cannot also provide for a certain amount of scholarly endeavor in connection with their other activities, it is of the utmost importance that they should be associated (by a system of administrative coöperation) with some institution which is a centre of original work.

5. The general character of a museum should be clearly determined at its very inception. Specialization and division of labor are essential for institutions as well as for individuals. It is only a great national museum which can hope to include all departments and which can with safety encourage growth in every direction.

6. Small museums, it is needless to say, cannot attempt specialization in the same degree as large ones, but the principles just

enunciated should be constantly kept in view, even by the least of them.

C. *Collections.*

1. The sources of collections are the following: (a) By gift; (b) by purchase; (c) by exchange; (d) by collection and exploration; (e) by construction; (f) through deposit or temporary loan.

a. *By gift.*—Acquisition by gift is a most important source, but very uncertain. If a museum has a plan to which it intends to adhere, a large proportion of the gifts offered to it will be unavailable; while, on the other hand, only a small proportion of the desiderata will ever be thus obtained. A museum may properly, by the offer of a large and complete collection illustrating a subject outside of its plan, be induced to expand its scope. In the case of a large benefaction of this kind, necessitating extensive changes in installation, there must always be careful consideration of the result. It should be borne in mind, however, that the random, thoughtless acceptance of proffered gifts, which in the course of a few years produces results by no means insignificant in the consumption of space and money for their care, may modify the plan of a museum in a most radical manner. It requires quite as much judgment and mental effort on the part of a museum officer to keep out unsuitable objects as to bring in those which are desirable.

b. *By purchase.*—Acquisition by purchase is often the only means of obtaining desirable objects, particularly so in the case of art museums, least so in natural history museums. Money is especially necessary for the filling of gaps in series obtained by gift or otherwise.

c. *By exchange.*—Acquisition by exchange is especially advantageous, since it enables a museum to dispose of unavailable duplicate material. When exchanges are made with well-conducted museums there is the additional advantage that the materials thus obtained have been studied and identified by expert authorities. Little is gained by conducting exchanges in a commercial spirit and in insisting on too exact valuations and balancing of equivalents, especially when the parties to the exchange are public institutions. Large museums in dealing with small ones may often advantageously give largely and receive comparatively little in return, since they not only become disembarrassed of useless duplicates not desired by institutions of equal rank, but are also building up sister institutions which may in time afford them much more substantial aid. Exchanges with private collectors may well be carried on in the same spirit, since the collector is thus encouraged to gather more material, in the midst of which unexpected treasures may come to light, and is also aided to build up a private collection which in time will probably fall into the hands of some public museum.

d. *By collecting and exploration.*—For all museums save those of art this is usually the most profitable and satisfactory, since by gathering fresh material in unexplored fields, new facts are discovered, science is enriched, and the reputation of the institution improved. Furthermore, material is obtained in such large quantities that there always remains much in the way of duplicate specimens valuable for exchange. A museum which carries its activities into unexplored fields secures for itself material which is unique and unobtainable by others, and thus makes itself a centre of interest for the entire world.

The smallest museum may enrich its collections by modest explorations under its own walls; it can do much by simply encouraging the people in the adjacent region to save what they accidentally encounter in the course of their daily pursuits. Explorations of this kind are preëminently the function of local and provincial museums.

e. *By construction.*—Any museum may do much to improve its exhibition series by the construction of models and the making of drawings and maps and by taking copies of important objects in its own collections, to secure material to be used in exchange. Even small museums may do this, for extensive workshops are not necessary and a specialist, himself devoid of mechanical skill, may accomplish marvelous things with the aid of a patient mechanic.

f. *Through deposit and temporary loan.*—Possessors of private collections will often lend them for purposes of exhibition or study, if assured that they will be properly cared for. Such loan collections often become permanent gifts. Single specimens, or small groups of objects, are still more frequently offered on deposit, and such deposits, when within the province of the museum, should be encouraged.

[In the United States National Museum small deposits are received for short periods, but large collections involving trouble and expense in installation, only with the understanding that they shall not be removed within a certain period—never less than two years.]

2. Collections which are encumbered by conditions as to manner of disposition and installation are usually sources of serious embarrassment. It is especially undesirable to accept either as a gift or as a loan any unimportant collection with the pledge that it shall be kept intact and installed as a unit. The acceptance of any collection, no matter how important, encumbered by conditions, is a serious matter, since no one can foresee how much these conditions may interfere with the future development of the museum.

3. Gifts, deposits and coöperation of all kinds may be greatly encouraged by liberal acknowledgment upon labels and in public reports. This is but simple justice to the generosity of the benefactor. It is also a legitimate way to gratify a natural and and praiseworthy sentiment; for a collection to the accumulation of which a man has devoted a lifetime becomes so connected with his own personality that it is but natural that he should wish his name to be permanently associated with it. If acknowledgment of this kind is made upon the individual label of each specimen, this will usually fully satisfy the desire of the donor that the individuality of his gift should be preserved—an arrangement much more satisfactory than a plan requiring that the objects shall be kept together and treated as a unit of installation.

Gifts and deposits are also encouraged by the fact that the buildings are fire-proof, the cases so built as to afford perfect protection, and the scheme of installation dignified and attractive. Collections of great value may well be afforded accommodations of a specially sumptuous character and such protection, in the case of priceless objects, as is afforded by special electric attachments.

4. Since the plan and character of a museum is largely determined for all time by the nature of the collections which fall first into its possession, at the time of its organization, the authorities in charge of such an institution at the time of organization should be exceedingly careful in accepting materials which are to serve as a nucleus for its future growth.

[It is not unusual for boards of trustees, having erected a building, to proceed at once to partially fill it with showy material before the staff has been appointed or a plan considered. This can only be characterized as pernicious activity which is certain to result in more harm than good. A plan having been determined upon and a director selected, the collections may be developed with much less expenditure and with any degree of rapidity which may be desired.]

D. *Museum Officers.*

1. A museum without intelligent, progressive and well-trained curators is as ineffective as a school without teachers, a library without librarians, or a learned society without a working membership of learned men.

2. Museum administration has become one of the learned professions, and success in this field can only be attained as the result of years of study and experience in a well-organized museum. Intelligence, a liberal education, administrative ability, enthusiasm, and that special endowment which may be called 'the museum sense' are prerequisite qualifications.

Each member of the museum staff should become an authority in some special field of research, and should have time for investigation and opportunity to publish its results.

3. A museum which employs untrained curators must expect to pay the cost of their education in delays, experimental failures and waste of materials.

4. No investment is more profitable to a museum than that in its salary fund, for only when this is liberal may the services of a permanent staff of men of established reputation be secured.

Around the nucleus of such a staff will naturally grow up a corps of volunteer assistants, whose work properly assisted and directed will be of infinite value.

5. Collaborators, as well as curators, may be placed upon the staff of a large museum, the sole duty of the former being to carry on investigations, to publish, and, if need be, to lecture.

6. Volunteers may be advantageously employed either as curators and custodians, or collaborators. Such coöperation is especially desirable and practicable when a museum is situated in the same town with a college or university, or in a national capital where there are scientific bureaus connected with the government. Professors in a university or scientific experts in the government service often find it a great benefit to have free access to the facilities afforded by a museum, and are usually able to render useful service in return. Younger men in the same establishments may be employed as volunteer aids, either in the museum or in the field.

7. No man is fitted to be a museum officer who is disposed to repel students or inquirers, or to place obstacles in the way of access to the material under his charge.

8. A museum officer or employee should, for obvious reasons, never be the possessor of a private collection.

9. The museum which carries on explorations in the field as a part of its regular work has great advantage over other institutions in holding men of ability upon its staff and in securing the most satisfactory results from their activities. No work is more exhaustive to body and mind than the care of collections, and nowhere are enthusiasm and abundant vitality more essential. Every museum must constantly obtain new material through exploration, and it is better that this exploration should be done by the men who are to study the collections and arrange them in the museum than that this work should be placed in the hands of others.

10. In a large museum staff it is almost essential that certain persons should give their attention chiefly to administrative and financial matters, thus leaving their associates free from occupation of this description. The business affairs of a museum cannot be conducted with too great promptness and precision. It is desirable, however, that the administrative officers of a museum should be men who comprehend the meaning of museum work and are in sympathy with its highest aims, and that its business affairs and scientific work should be controlled by the same executive head.

E. *Museum Buildings.*

1. The museum building should be absolutely fire-proof and substantially constructed; the architecture simple, dignified and appropriate—a structure worthy of the treasures to be placed within.

2. Above all things the interior should be well lighted and ventilated, dry and protected from dust. The halls should be well proportioned, the decoration simple and restful to the eye. No decorative features should be permitted which might draw attention from the collections or reduce the floor or wall space.

3. While the museum building should be planned with reference to the character of the collections it is to contain, the fact that unexpected development of rapid growth in some one direction may necessitate the rearrangement and reassignment of halls to different departments should always be kept in mind.

4. Since no two museums can be alike, there can be no general uniformity in their buildings. It is manifestly undesirable then that a board of trustees should erect a building for a museum before its character is decided upon or its staff appointed; or that the opinion of the architect of a museum building should be allowed to outweigh the judgment of the experts who are responsible for its utilization after completion. Museum architecture affords no exception to the principle that an edifice should be perfectly adapted to the purpose for which it is designed. No architectural effect which lessens the usefulness of the building can be pleasing to an intelligent public.

F. *Accessories to Museum Work.*

1. A well-equipped museum requires as accessories to its work:

a. A reference library for the use of staff, students and visitors.

b. Laboratories for the classification of material, for the storage of the study-series, and for the use of students and investigators.

c. Workshops, for preparation, mounting and repair of specimens, and the making and adjustment of mounts and cases, and storage rooms for material not yet available. A printing press is a most essential feature.

d. An assembly hall, for public lectures, society meetings and special exhibitions.

e. A bulletin, or other official publication, to preserve the history of its activities, to maintain its standing among similar institutions, to serve as a means of communication with correspondents, and to exchange for specimens and books for the library.

2. In addition to local accessories, the opportunity for exploration and field work are equally essential, not only because of considerations connected with the efficiency of the staff, but for the general welfare of the institution. Other things being equal, exploration can be carried on more effectively by the museum than by any other institution of learning, and there is no other field of research which it can pursue to better advantage.

## THE FUTURE OF MUSEUM WORK.

A. *The Growth of the Museum Idea.*

1. There can be no doubt that the importance of the museum as an agency for the increase and diffusion of knowledge will be recognized so long as interest in science and education continues to exist. The prediction of Professor Jevons in 1881, that the increase in the number of museums of some sort or other must be almost coextensive with the progress of real popular education, is already being realized. Numerous local museums have been organized within the past fifteen years in the midst of new communities. Spécial museums of new kinds are developing in the old centres, and every university, college and school is organizing

or extending its cabinet. The success of the Museums Association in Great Britain is another evidence of the growing popularity of the museum idea, and similar organizations must of necessity soon be formed in every civilized country.

2. With this increase of interest there has been a corresponding improvement in museum administration. More men of ability and originality are engaging in this work, and the results of this are manifest in all its branches.

The museum recluse, a type which had many representatives in past years, among them not a few eminent specialists, is becoming much less common, and this change is not to be regretted. The general use of specimens in class-room instruction and, still more, the general introduction of laboratory work in the higher institutions, has brought an army of teachers into direct relations with museum administration, and much support and improvement has resulted.

3. Museum administration has become a profession, and the feeling is growing more and more general that it is one in which talents of a high order can be utilized. It is essential to the future development of the museum that the best men should be secured for this kind of work, and to this end it is important that a lofty professional standard should be established.

B. *Public Appreciation of the Material Value of Collections.*

1. The museum of nature or art is one of the most valuable material possessions of a nation or a city. It is, as has well been said, 'the people's vested fund.' It brings not only world-wide reputation, but many visitors and consequent commercial advantage. What Alpine scenery is to Switzerland, museums are to many neighboring nations. Some one declares that the Venus of Melos has attracted more wealth to Paris than the Queen of Sheba brought to King Solomon, and that but for the possession of their collections (which are intrinsically so much treasure) Rome and Florence would be impoverished towns.

This is thoroughly understood by the rulers of modern Italy. We are told that the first act of Garibaldi after he had entered Naples in 1860 was to proclaim the city of Pompeii the property of the nation, and to increase the appropriation for excavations so that these might be carried on with greater activity. He appreciated the fact that a nation which owns a gold mine ought to work it, and that Pompeii could be made for Naples and for Italy a source of wealth more productive than the gold mines of Sacramento. If capital is an accumulation of labor, as economists say, works of art which are the result of the highest type of labor must be capital of the most productive character. A country which has rich museums attracts to itself the money of travelers, even though it may have no other source of wealth. If, besides, the populace is made to understand the interest which is possessed by their treasures of art they are inspired with the desire to produce others of the same kind, and so, since labor increases capital, there is infinite possibility for the growth of national prosperity. It is evident then that too much money cannot be devoted to the formation of museums, to their maintenance, and to the education of the people by this means.

Suggestive in this same connection is this remark of Sir William Flower to the effect that the largest museum yet erected, with all its internal fittings, has not cost so much as a single fully equipped line of battleships, which in a few years may be either at the bottom of the sea or so obsolete in construction as to be worth no more than the material of which it is made.

This principle was well stated more than half a century ago by Edward Edwards in his treatise on the 'Administrative Econ-

omy of the Fine Arts in England,' as follows:

"In addition to the broad principle that public funds can never be better employed than in the establishment of institutions tending at once to refine the feelings and to improve the industry of the whole population, there is the subordinate but yet important ground of inducing and enabling private persons greatly to benefit the public by contributing towards the same end."

"No country," he continues, "has more cause to be proud of that munificent spirit of liberality which leads private individuals to present or bequeath to the community valuable collections which it has been the labor of their lives to form; but to give due effect to this liberality and to make that effect permanent, it is necessary that the state step in and contribute its sanction and its assistance; and in many cases the very munificence of spirit which has formed an immense collection, and given birth to the wish to make it national, has, by its own excess, made that wish powerless without the active aid of the legislature. The actual cost, and still more the inherent value of the collections of Sloane, Elgin and Angerstein, made them in reality gifts to the nation, although they could never have been acquired (without gross injustice to the descendants of the large minded collectors) had not Parliament made certain pecuniary advances on account of them. Whilst but for the foundation of the British Museum and of the National Gallery, the collections of Cracherode and Holwell Carr, of Beaumont, of Sir Joseph Banks and of King George III., would have continued in the hands of individuals."

C. *Public Appreciation of the Higher Function of Museums.*

1. Museums, libraries, reading rooms and parks have been referred to by some wise person as 'passionless reformers,' and no better term can be employed to describe one of the most important of their uses.

The appreciation of the utility of museums to the great public lies at the foundation of what is known as 'the modern museum idea.' No one has written more eloquently of the moral influence of museums than Mr. Ruskin, and whatever may be thought of the manner in which he has carried his ideas into practice in his workingmen's museum, near Sheffield, his influence has undoubtedly done much to stimulate the development of the 'people's museum.' The same spirit inspired Sir Henry Cole when he said to the people of Birmingham in 1874:

"If you wish your schools of science and art to be effective, your health, your air and your food to be wholesome, your life to be long and your manufactures to improve, your trade to increase and your people to be civilized, you must have museums of science and art to illustrate the principles of life, wealth, nature, science, art and beauty."

I myself never shall forget the words of the late Sir Philip Cunliffe Owen, of South Kensington, who said to me some years ago:

"We educate our working people in the public schools, give them a love for refined and beautiful objects, and stimulate in them a desire for information. They leave school, go into the pursuits of town life, and have no means provided for the gratification of the tastes which they have been forced to acquire, and are condemned to a monotonous, depressing life in the midst of smoky chimneys and dingy walls. It is as much the duty of the government to provide them with museums and libraries for higher education as it is to establish schools for their primary instruction."

The development of the modern museum idea is indeed due to Great Britain in much greater degree than to any other nation, and the movement dates from the period of the great Exhibition of 1851, which marked an epoch in the intellectual progress of English speaking peoples.

2. The future of the museum, as of all similar public institutions, is inseparably associated with the continuance of modern civilization, by means of which those sources of enjoyment which were formerly accessible to the rich only are now, more and more, placed in the possession and ownership of all the people (an adaptation of what Jevons has called 'the principle of the multiplication of utility') with the result that objects which were formerly accessible only to the wealthy, and seen by a very small number of people each year, are now held in common ownership and enjoyed by hundreds of thousands.

In this connection the maintenance of museums should be especially favored, because, as has been shown, these, more than any other public agency, are invitations to the wealthy owners of private treasures, in the form of collections, to give them in perpetuity to the public.

3. If it be possible to sum up in a single sentence the principles which have been discussed in the present paper, that sentence should be phrased in these words:

The degree of civilization to which any nation, city or province has attained is well indicated by the character of its public museums and the liberality with which they are supported.

G. Brown Goode.

U. S. National Museum.

## *THE PROCESSES OF LIFE REVEALED BY THE MICROSCOPE: A PLEA FOR PHYSIOLOGICAL HISTOLOGY.**

It is characteristic of the races of men that almost at the dawn of reflection the first question that presses for solution is this one of life; life as manifested in men and in the animals and plants around them. What and whence is it and whither does it tend? Then the sky with its stars, the earth with its sunshine and storm, light and darkness, stand out like great mountain peaks demanding explanation. So in the life of every human being, repeating the history of its race, as the evolutionists are so fond of saying, the fundamental questions are first to obtrude themselves upon the growing intelligence. There is no waiting, no delay for trifling with the simpler problems; the most fundamental and most comprehensive come immediately to the fore and alone seem worthy of consideration. But as age advances most men learn to ignore the fundamental questions and to satisfy themselves with simpler and more secondary matters as if the great realities were all understood or non-existent. No doubt to many a parent engaged in the affairs of society, politics, finance, science or art, the questions that their children put, like drawing aside a thick curtain, bring into view the fundamental questions, the great realities; and we know again that what is absorbing the power and attention of our mature intellect, what perhaps in pride we feel a mastery over, are only secondary matters after all, and to the great questions of our own youth, repeated with such earnestness by our children, we must confess with humility that we still have no certain answers. It behooves us then, if the main questions of philosophy and science cannot be answered at once, to attempt a more modest task and by studying the individual factors of the problem to hope ultimately to put these together and thus gain some just comprehension of the entire problem.

This address is therefore to deal, not with life itself, but with some of the processes or phenomena which accompany its manifestations. But it is practically impossible to do fruitful work according to the Baconian guide of piling observation on observation. This is very liable to be a dead mass devoid of the breath of life. It is a well known fact that the author of the Novum Organum, the key which Bacon supposed would serve as the open-sesame of all difficulties and yield certain knowledge, this potent key did not unlock many of the mysteries of science for its inventor. Every truly scientific man since the world began has recognized the necessity of accurate observation, and no scientific principle has ever yet been discovered simply by speculation; but every one who has really unlocked any of the mysteries of nature has inspired, made alive, his observations by the imagination, he has, as Tyndall so well put it, made a scientific use of the

* Presidential address delivered before the American Microscopical Society, Wednesday evening, Aug. 21, 1895.

imagination and created for himself what is known as the 'working hypothesis.' It must be confessed that for some investigators the 'hypothesis' becomes so dear that if the facts of nature do not conform to the hypothesis, 'so much the worse for the facts.' But for the truly scientific man, the hypothesis is destined solely to enable him to get the facts of nature in some definite order, an order which shall make apparent their connection with the great order and harmony which is believed to be present in the universe.

If the working hypothesis fails in any essential particular he is ready to modify or discard it. For the truly inspired investigator, one undoubted fact weighs more in the balance than a thousand theories.

At the very threshold of any working hypothesis for the biologist, this question as to the nature of the energy we call life must be considered. The great problem must receive some kind of a hypothetical solution. What is its relation to the energies of light, heat, electricity, chemism and the other forms discussed by the physicist? Are its complex manifestations due only to these or does it have a character and individuality of its own? If we accept the ordinarily received view of the evolution of our solar system, the original fiery nebula in which heat reigned supreme, slowly dissipated part of its heat, and hurled into space the planets, themselves flaming vapors, only the protons of the solid planets. As the heat became further dissipated there appeared in the cooling mass manifestations of chemical attraction, compounds at first gases, then liquids, and finally, on the cooling planets, solids appeared. Lastly, upon our own planet, the earth, when the solid crust was formed and the temperature had fallen below the boiling point of water, the seas were formed and then life appeared. Who could see, in the incandescent nebula, the liquids and solids of our planet and the play upon them of chemism, of light, heat, electricity, cohesion, tension and the other manifestations so familiar to all? And yet, who is there that for a moment believes that aught of matter or energy was created in the different stages of the evolution? They appeared or were manifested just as soon as the conditions made it possible. So it seems to me that the energy called Life manifested itself upon this planet when the conditions made it possible, and it will cease to manifest itself just as soon as the conditions become sufficiently unfavorable. It was the last of the forms of energy to appear upon this planet, and it will be the first to disappear.

In brief, it seems to me that the present state of physical and physiological knowledge warrants the assumption, the working hypothesis, that life is a form of energy different from those considered in the domain of physics and chemistry. This form of energy is the last to appear upon our planet, last because more conditions were necessary for its manifestations. It, like the other forms of energy, requires a material vehicle through which to act, but the results produced by it are vastly more complex. Like the other energies of nature it does not act alone. It acts with the energies of the physicist, but as the master; and under its influence the manifestations pass infinitely beyond the point where for the ordinary energies of nature it is written 'thus far and no farther.'

It can be stated without fear of refutation that every physiological investigation shows with accumulating emphasis that the manifestations of living matter are not explicable with only the forces of dead matter, and the more profound the knowledge of the investigator the more certain is the testimony that the life energy is not a mere name. And strange to say, the physicist and chemist are most emphatic in de-

claring that life is an energy outside their domain.

The statements of a chemist, a physicist and a biologist are added. From the character and attainments of these men, their testimony, given after years of the most earnest investigation and reflection, is worthy of consideration.

When Liebig was asked if he believed that a leaf or a flower could be formed or could grow by chemical forces, he answered: "I would more readily believe that a book on chemistry or on botany could grow out of dead matter by chemical processes."

"The influence of animal or vegetable life on matter is infinitely beyond the range of any scientific inquiry hitherto entered on. Its power of directing the motions of moving particles, in the demonstrated daily miracle of our human free will, and in the growth of generation after generation of plants from a single seed, are infinitely different from any possible result of the fortuitous concourse of atoms; and the fortuitous concourse of atoms is the sole foundation in philosophy on which can be founded the doctrine that it is impossible to derive mechanical effect from heat otherwise than by taking heat from a body at a higher temperature, converting at most a definite proportion of it into mechanical effect and giving out the whole residue to matter at a lower temperature." Sir William Thomson (Lord Kelvin).

"The anagenetic (vital) energy transforms the face of nature by its power of assimilating and recompounding inorganic matter, and by its capacity for multiplying its individuals. In spite of the mechanical destructibility of its physical basis (protoplasm) and the ease with which its mechanisms are destroyed, it successfully resists, controls and remodels the catagenetic (physical and chemical) energies for its purpose." Cope.

What then are the manifestations of the life energy? And what are the processes which are discernible? All of us in whatever walk of life will recognize the saying of Gould: "Now when one looks about him the plainest, largest fact he sees is that of the distinction between living and lifeless things."

As life goes on and works with power where the unaided eye fails to detect it, the microscope—marvelous product of the life energy in the brain of man—shows some of these hidden processes. It has done for the infinitely little on the earth what the telescope has done for the infinitely great in the sky.

Let us commence with the little and the simple. If a drop of water from an aquarium, stream or pool is put under the microscope many things appear. It is a little world that one looks into, and like the greater one that meets our eye on the streets, some things seem alive and some lifeless. As we look we shall probably find, as in the great world that the most showy is liable in the end to be the least interesting. In the microscopic world there will probably appear one or more small rounded masses which are almost colorless. If one of these is watched, lo, it moves, not by walking or swimming, but by streaming itself in the direction. First a slender or blunt knob appears, then into it all of the rest of the mass moves, and thus it has changed its position. If the observation is continued, this living speck, which is called an amœba, will be seen to approach some object and retreat; indeed, it comports itself, as if sensitive, with likes and dislikes. If any object suitable for food is met in its wanderings the living substance flows around it, engulfs it and dissolves the nutrient portions and turns them into its own living substance; the lifeless has been rendered alive. If the eye follows the speck of living matter, the marvels do not cease. After it has grown to a certain size, as if by an invisible string, it

constricts itself in the middle and finally cuts itself in two. The original amœba is no more; in its place there are two. Thus nearly at the bottom of the scale of life are manifested all of the fundamental features, the living substance moves itself, takes nourishment, digests it and changes non-living into living substance and increases in size; it seems to feel and to avoid the disagreeable and choose the agreeable and finally it performs the miracle of reproducing its kind, of giving out its life and substance to form other beings, its offspring.

It is the belief of many biologists that the larger and complex forms even up to man himself may be considered an aggregation of structural elements originally more or less like the amœba just described; but instead of each member of the colony, each individual itself carrying on all the processes of life independently as with the amœba, there is a division of labor. Some move, some digest, some feel, think and choose, some give rise to new beings, all change lifeless matter into their own living substance.

The processes and phenomena by which a new individual is produced are included under the comprehensive term, Embryology.

All organisms, great or small, are but developments of minute germs budded off by the parent or parents, and the way in which these minute beginnings develop into perfect forms like their parents can only be followed by the aid of a microscope. Indeed, in no field of biology has the microscope done such signal service in revealing the processes of life.

The method of the production of a new being with the amœba, as we have just seen, is for the parent to give itself entire to its offspring—the parent ceasing to be in producing its offspring. With some other lowly forms a part of the body of the parent buds out, grows and finally falls off as an independent organism, or remains connected with the parent to form a colony. In the plant world a familiar example of a colony is represented by the cactus that the children call 'Old Hen and Chickens.'

In the higher animals, however, where specialization has been carried to its extreme limit, some myriads of cells forming the body are set apart to produce motion, others digest food, still others think and feel, while comparatively few, the *germ cells* are destined for the continuation of the race. In the higher and highest forms especially, all observation goes to show that the life energy, not satisfied with the mere vitalization of matter and a dead level of excellence, is aiming at perpetual ascent, greater mastery over matter and its physical forces. For the more certain attainment of this end, the production of offspring is no longer possible for one individual; two wholly separate individuals must join, each contributing its share of the living matter which is to develop into a new being. In this way the accumulated acquirements of two are united with the consequent increase in the tendencies and impulses for modification, and nearly double the protection for the offspring. Thus in striking contrast with the amœba, where the single parent gives all of itself to form offspring, and in so doing disappears and loses its individuality, the higher forms, while two must unite to form the offspring, the parents remain and retain their individuality and the ability to produce still other offspring. The process by which this is accomplished may be traced step by step with the microscope. A germ cell of the father and one of the mother fuse together, and from this new procreative cell, formed by the fusion of two with all their possibilities combined, the new individual arises. This certain knowledge is the result of the profound investigation of the last few years and shows the literalness of the scriptural statement, 'they shall be one flesh.'

After this fusion of the father and mother germ cells, the single cell thus formed, like the amœba, divides into two, and these into four and so on, but unlike the amœba all the cells remain together. Within this cellular mass, as if by an unseen builder, the cells are deftly arranged in their place, some to form brain, some heart, some the digestive tract, others for movement, so that finally from the simple mass of cells, originally so alike, arises the complex organism, fish or bird, beast or man. How perfectly the word *offspring* describes the life process in the production of this new being! That the child should resemble both father and mother is thus made intelligible, for it is a part of both. Yes, further, it may resemble grandfather or great grandfather or mother, for truly it is a part of them, their life conserved and continued. There is no new life, it is only a continuation of the old: '*Omne vivum ex vivo*,' all life from life. But the demonstration of this prime fact required a microscope, and it is an achievement of the last half of this century. How counter this statement still is to the common belief of mankind we may perhaps better appreciate if we recall our own youth, and remember with what absolute confidence we expected the stray horsehairs we had collected and placed in water to turn into living snakes. The belief that it is an every-day occurrence for living beings to arise from lifeless matter was not by any means confined to those uneducated in biology. It was held by many scientific men within the memory of most of us. Indeed, this goblin of *spontaneous generation*, even for the scientific world, has been laid low so recently that the smoke of battle has scarcely yet cleared from the horizon.

In the complex body of animals, as stated above, the constituent elements perform different functions. Is there any hint of the way in which the action is accomplished? Let us glance at two systems, the nervous and the glandular, widely different in structure and function. All know how constantly the glands are called into requisition, the salivary glands for saliva, those of the stomach and pancreas for their digestive juices, etc. If we take now the pancreas as an example, and that of a living fasting animal is put under the microscopic so that its constituent cells can be observed, it will be seen that they are clouded, their outlines and that of their nuclei being very vague and indistinct. The cell is apparently full of coarse grains. If now the animal is fed, as the digestion proceeds the pancreas pours out its juice. At the same time the granules and with them the cloudiness gradually disappear, the cells become clear and both they and their nuclei are sharply outlined. That is, the substance which is to form the pancreatic juice is stored in the cells in the form of granules during the periods of rest and held until the digestive agent is demanded, and if the demand is great all the granules may be used up. But as soon as the demand ceases the cells begin again their special vital action, and again the granules begin to appear and increase in number until finally the cells become so full that they are fully charged and again ready to pour forth the digestive fluid. This is a daily, almost an hourly process. Let us take another example in which there would almost appear an organic memory on the part of the gland cells. No doubt all have seen the clear jelly-like masses surrounding the eggs of frogs and salamanders. Whence comes this jelly that is so resistant to the agents that work so quickly the destruction of ordinary organic matter? As spring advances the cells of the oviduct increase enormously in size. The microscope shows this increase to be due to a multitude of clear granules. As the eggs move along, the ova are coated with the jelly formed from the granules

given out by the cells. As this material for the jelly is poured out the cells gradually shrink to their original size, and then wait another twelve months before doing their destined work.

If one can thus catch a glimpse of some of the finer processes taking place in gland action, how is it with nervous action, the highest function of which living matter is capable? While it has been known for a long time that the nervous system is the organ of thought and feeling and the director and coördinator of the motions of the body, and many speculations have been made concerning the processes through which the nervous tissue passes in performing its functions, it was left to an American student, Dr. Hodge, to first successfully show that there were visible changes through which the nervous system passes in its work. The question is, can the activity of the nervous system be traced as surely by changes occurring in the living matter forming its basis as the action of a gland can be seen by the study of the gland cells?

The demonstration is simple now that the method has been shown. No doubt every one has had the experience of failing to perform some difficult muscular action at one time and then at another of doing it with ease, or of finding true the reverse of the adage 'practise makes perfect.' For example, in a trial of skill, as in learning to ride a bicycle, all the complicated action may be performed with considerable ease and certainty when one is fresh, but as the practice continues the results become progressively less and less successful, and finally with increasing weariness there is only failure and one must rest. We say the muscles are tired; this is true in part, but of much greater importance is the fatigue of the nervous system, as this furnishes the impulses for the action and coördination of the muscles. Now, as muscular action can be seen and the amount can be carefully controlled, here was an exact indicator of the time and amount of the nervous activity. Furthermore, as animals have two similar sides, one arm or leg may work and the other remain at rest, and consequently corresponding sides of the nervous system may be active and at rest. By means of electrical irritation one arm of a cat or other animal was caused to move vigorously for a considerable time, the other arm remaining at rest. Then the two sides of the nervous system, that is the pairs of nerves to the arms with their ganglia and a segment of the myel (spinal cord), were removed and treated with fixing agents, and carried through all the processes necessary to get thin sections capable of accurate study with the microscope. Finally, upon the same glass slide are parts of the nervous system fatigued even to exhaustion, and corresponding parts of the same animal which has been at rest. Certainly if the nervous substance shows the result or processes of its action the conditions are here perfect. Fatigued nerve cells are side by side with those in a state of rest. The appearances are clear and unmistakable; the nucleus has markedly decreased in size in the fatigued cells and possesses a jagged irregular outline in place of the smooth rounded form of the resting cells. The cell substance is shrunken in size and possesses clear scattered spaces or a large clear space around the nucleus.

If the nervous substance was not fixed at once, but remained in the living animal for twelve to twenty-four hours in a state of repose, the signs of exhaustion disappeared and the two sides appeared alike. By studying preparations made after various periods of repose all the stages of recovery from exhaustion could be followed.

For possible changes in normal fatigue sparrows, pigeons and swallows and also honey bees were used. For example, if

two sparrows or two honey bees as nearly alike as possible were selected, the nervous system of one being fixed in the morning after the night's rest and that of the other after a day of toil, the changes in the cells of the brain of the honey bee or sparrow and in the spinal ganglia of the sparrow were as marked as in case of artificial fatigue. After prolonged rest then the nerve cells are *charged*, so to speak—they are full and ready for labor, but after a hard day's work they are *discharged*, shrunken and exhausted.

There is one more step in this brilliant investigation. If in the morning after sleep and rest animals and men are full of vigor, and in the evening are weary and exhausted, how like is it to the beginning and end of life? In youth so overflowing with vigor that to move, to act, is a pleasure and continued rest a pain. But in the evening of life a warm corner and repose are what we try to furnish those whose work is done. How is this correlated in the cells of the nervous system with the states of rest and fatigue? With a well-nourished child which died from one of the accidents of birth the nerve cells showed all the characters of cells at rest and fully charged. In a man dying naturally of old age the cells showed the shrunken nuclei and all the appearances of exhausting fatigue. In the one was the potentiality of a life of vigorous action; the other showed the final fatigue—the store of life-energy had been dissipated and there was no recovery possible.

For the animals that possess an undoubted nervous system probably all would admit that there is some sort of nervous action corresponding to sensation; but what of living matter in the humbler forms where no nervous system can be found? That these have vital motion, that they breathe, nourish themselves, grow and produce offspring, none can deny. Do they have anything comparable with sensation? As most of the lower forms are minute, the microscope comes to our aid again, and in watching these lowliest living beings it is found that they discriminate and choose going freely into some portions of their liquid world and withdrawing from other portions. If some drug which is unusual, or we must believe disagreeable, is added to a part of the water they withdraw from that part. It seems to have the same effect as disagreeable odors on men and animals. On the other hand, there are substances which attract, and into the water containing these they enter with eagerness. Strange is it too that as proved by experiment if an unattractive substance is used, and also one on the other side that has been still more attractive, the less disagreeable is selected, the less of two evils is chosen.

As man, the horse, dog and many other animals adapt themselves gradually to temperatures either very cold or very warm, and that too by a change in their heat-regulating power rather than by a change of hairy or other clothing, so these lowly organisms are found in nature in water at temperatures from near freezing up to 60°–80° C., a point approaching that of boiling water. It may be answered that each was created for its place; but by means of a microscope and a delicate thermostat, to be certain of every step and to see all the results, Dr. Dallinger through a period of seven years accustomed the same unicellular organism and its progeny to variations of temperature from 15°–20° C., *i. e.*, about the temperature of a comfortable sitting-room, up to 70° C. For those at the cooler temperature it was death to increase rapidly the temperature 10°, and for those at the higher temperature it was equally fatal to lower the heat to 15°–20°, their original normal temperature. These examples seem to show that it is one of the fundamental character-

istics of living substances, whether in complex or simple forms, to adapt themselves to their environment.

There is another fact in nature that the microscope has revealed and that fills the contemplative mind with wonder and an aspiration to see a little farther into the living substance, and so perchance discover the hidden springs of action. This fact may be called *cellular altruism*. In human society the philanthropist and soldier are ready at any time to sacrifice themselves for the race or the nation. With the animals the guards of the flock or herd are equally ready to die in its defense.

So within each of the higher organisms the microscope has shown a guarding host, the leucocytes or white blood corpuscles. The brilliant discoveries in the processes of life with higher forms have shown that not only is there a struggle for existence with nature and against forms as large or larger than themselves, but each organism is liable to be undermined by forms, animal and vegetable, infinitely smaller than themselves, insignificant and insiduous but deadly. Now to guard the body against these living particles and the particles of dust that would tend to clog the system there is a vast army of amœba-like cells, the leucocytes, that go wherever the body is attacked and do battle. If the guards succeed the organism lives and flourishes, otherwise it dies or becomes weakened and hampered. This much was common scientific property three years ago, when one of our members (Miss Edith J. Claypole) came to my laboratory for advanced work. I discussed with her what has just been given, and told her that there still remained to be solved the problem what becomes of the clogging or deleterious material which the leucocyte take up? These body guards are after all a part of the organism, and for them simply to engulf the material would not rid the body entirely of it, and finally an inevitable clogging of the system would result. The problem is simple and definite: What becomes of the deleterious substances, bacteria and dust particles, that get into the body and become engulfed by the leucocytes? Fortunately, for the solution of this problem, in our beautiful Cayuga Lake there is an animal, the *Necturus*, with external gills through which the blood circulates for its purification. So thin and transparent is the covering tissue in these gills that one can see into the blood stream almost as easily as if it were uncovered. Every solid constituent of the blood, whether red corpuscle, white corpuscle, microbe or particle of dust, can be seen almost as clearly as if mounted on a microscopic slide.

Into the veins of this animal was injected some lampblack mixed with water, a little gum arabic and ordinary salt, an entirely non-poisonous mixture. Thousands of particles of carbon were thus introduced into the blood and could be seen circulating with it through the transparent gills. True to their duty, the white corpuscles in a day or two engulfed the carbon particles, but for several days more the leucocytes could be seen circulating with the blood stream and carrying their load of coal with them. Gradually the carbon laden corpuscles disappeared and only the ordinary carbon-free ones remained. Where had the carbon been left? Had it been simply deposited somewhere in the system? The tissues were fixed and serial sections made. The natural pigment was bleached with hydrogen dioxid, so that if any carbon was present it would show unmistakably. With the exception of the spleen, no carbon appeared in the tissues, but in many places the carbon-laden leucocytes were found. In mucous cavities and on mucous surfaces and on the surface of the skin were many of them; in the walls of organs were many more apparently on their way to the surface with the load, that is the carbon is

actually carried out of the tissues upon the free surfaces of the skin and mucous membranes where, being ouiside of the body, it could no more interfere in any way with it. But what was the fate of the leucocytes that carried the lampblack out of the tissues? They carry their load out and free the body, but they themselves perish. They sacrifice themselves for the rest of the body as surely as ever did soldier or philanthropist for the betterment or the preservation of the state.

Thus I have tried to sketch in briefest outline some of the phenomena or processes of life revealed by the microscope. Most of those discussed have come under my own personal observation and are therefore to me particularly real and instructive. But to every one long familiar with the microscope and with the literature of biology, many other examples will occur, some of them even more striking. This discussion has been confined to the above also because it seems to me to show with great clearness the way in which we can justifiably hope to do fruitful work in the future. This sure way it seems to me is the study of structure and function together; the function or activity serving as a clue and stimulus to the investigator for finding the mechanism through which function is manifested and thus give due significance to structural details which, without the hint from the function, might pass unnoticed.

This kind of microscopical study, it seems to me, may be well designated as Physiological History. It is in sharp contrast with ordinary histology, in which too often the investigator knows nothing of the age, state of digestion or of fasting, nervous activity, rest or exhaustion. Indeed, in many cases it is a source of congratulation if he knows even the name of the animal from which the tissue is derived. Such haphazard observation has not in the past, and is not likely in the future, to lead to splendid results. If structure, as I most firmly believe, is the material expression of function, and the sole purpose of the structure is to form the vehicle of some physiological action, then the structure can be truly understood only when studied in action or fixed and studied in the various phases of action.

Indeed, if one looks only for form or morphology in the study of histology, the very pith and marrow is more than likely to be lost.*

For example, if one wished to study the comparative histology of the pancreas and were to take pieces from various animals to be compared without regard to their condition of fasting or digestion, he might find the coarser anatomical peculiarities in each. In all probability he would also find two distinct structural types, with various gradations. One type with clearly defined cells and nuclei, the other with the cells clouded, filled with granules and with the outlines of cells and their nuclei almost indiscernible. Between these there might be various gradations in the different forms. And yet, from what has been stated above, it is plain that all these different structural appearances represent phases of activity, and all might have come from the selfsame animal. In like manner, if certain parts of

*Although in a different field, the words of Osborn in discussing the unknown factors of evolution are so pertinent that they may well be quoted: "My last word is that we are entering the threshold of the evolution problem, instead of standing within the portals. The hardest tasks lie before us, not behind us." "We are far from finally testing or dismissing these old factors [of evolution], but the reaction from speculation upon them is in itself a silent admission that we must reach out for some unknown quantity. If such does exist there is little hope that we shall discover it except by the most laborious research; and while we may predict that conclusive evidence of its existence will be found in morphology, it is safe to add that the fortunate discoverer will be a physiologist, 'armed with a microscope,' I would like to add" *Am. Nat.*, May, 1895.

the nervous system were to be studied comparatively, and the tissue taken from one animal after refreshing sleep and rest, from another after exhausting labor, another in infancy, and another from an animal decrepit with years, the difference in general appearance and in structural details would be striking enough to satisfy any morphologist that, as with the structure of the pancreatic cells, there were two or more distinct types; but the physiological histologist would recognize at once that the differences so much insisted upon represented different phases of activity, and, as with the pancreatic cells, might be all represented in the same animal at different times.

I would be far from saying that there are no structural differences in the different animals independent of any particular phase of functional activity; but if these only are sought and the others neglected, the physiological appearances will often obtrude and confuse, if they do not utterly confound.

I have therefore for the last ten years urged my students, and mean to go on advocating with all the earnestness of which I am am capable, that, in studying an organism or its tissues, the investigator, to gain certain knowledge, must know all that it is possible to learn concerning the age, health, state of nervous, muscular and digestive activity; in fact, all that it is possible to find out about the processes of life that are going on and have gone on when the study is made.

Fortunately, there are some microscopic forms in which the entire study can be made while the creature is alive. With the higher organisms also some of the living elements, as the white corpuscles, can be studied and their various actions and structural changes observed for a considerable time. Most of the tissues of the higher forms, however, cannot be thus studied, and the best that can be done is to fix the different phases of action, as by a series of instantaneous photographs, then with a kind of mental kinetoscope put these together and try to comprehend the whole cycle.

Fortunately for the histologist the incessant experimentation of the last twenty-five years has brought to knowledge chemical substances which do for the tissues the wonder that was ascribed to the mythical Gorgon's head—to kill instantly and to harden into changeless permanence all that gazed upon it. So the tissues may be fixed at any phase, and then studied at length. If then the investigator observes and keeps record of every point that may have an influence on the structural appearances, whether shown by experience or suggested by insight, and this record always accompanies the specimen, thus and thus only, it seems to me, can he feel confident that he is liable to gain real knowledge from the study, knowledge that represents actuality and which will serve as the basis for a newer and more complete unraveling of the intricacies of structure, an approximate insight into the mechanism through which the life energy manifests itself.

And so, with all the light that physics and chemistry can give, commencing with the simplest problems and being careful that every factor that can influence the result is being duly considered, the microscopist can go forward with enthusiasm and with hope, not with the hope that the great central question can be answered in one generation, perhaps not in a thousand, but confident that if each one adds his little to the *certain* knowledge of the world, then in the fullness of time the knowledge of living substance and the life processes will be so full and deep that what *life is*, though unanswered, may cease to be the supreme question.

SIMON HENRY GAGE.

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*CONSCIOUSNESS AND EVOLUTION.*

THE quotation by Professor Cattell in SCIENCE, July 26, of Professor Cope's table (from the *Monist*, July, 1895) shows that he was equally struck by it with myself. Prof. Cope gives in this table certain positions on points of development, in two contrasted columns, as he conceives them to be held by the two camps of naturalists divided in regard to inheritance into Preformists and the advocates of Epigenesis. The peculiarity of the Epigenesis column is that it includes certain positions regarding consciousness, while the Preformist column has nothing to say about consciousness. Being struck with this I wrote to Professor Cope—the more because the position ascribed to consciousness seemed to be the same, in the main, as that which I myself have recently developed from a psychological point of view in my work on *Mental Development* (Macmillan & Co.). I learn from him that the table* is not new; but was published in the 'annual volume of the Brooklyn Ethical Society in 1891:' and the view which it embodies is given in the chapter on 'Consciousness in Evolution;' in his *Origin of the Fittest* (Appletons, 1887).

Apart from the question of novelty in Professor Cope's positions—and that Mr. Cattell and I should both have supposed them so can only show that we had before read hastily; I myself never looked into Professor Cope's book until now—I wish to point out that the placing of consciousness, as a factor in the evolution process, exclusively in the Epigenesis column, appears quite unjustified. It is not a question, as Mr. Cattell seems to intimate in his note referred to in SCIENCE, July 26, of a causal interchange between body and mind. I do not suppose that any naturalist would hold to an injection of energy in any form into the natural processes by consciousness; though, of course, Professor Cope himself can say whether such a construction is true in his case. The psychologists are, as Mr. Cattell remarks, about done with a view like that. The question at issue when we ask whether consciousness has had a part in the evolutionary process is, I think, as to whether we say that the presence of consciousness—say in the shape of sensations of pleasure and pain—with its nervous or organic correlative processes, has been an essential factor in evolution; and if so, further, whether its importance is because it is through the consciousness aspect of it that the organic aspect gets in its work. Or, to take a higher form of consciousness, does the memory of an object as having given pleasure help an organism to get that object a second time? This may be true, although it is only the physical basis of memory in the brain that has a causal relation to the other organic processes of the animal.

Conceiving of the function of consciousness, therefore, as in any case not a *deus ex machina*, the question I wish to raise is whether it can have an essential place in the development process as the Preformists construe that process. Professor Cope believes not. His reasons are to appear fully in his proposed book. I believe that the place of consciousness may be the same—and may be the essential place that Mr. Cope gives it in his left-hand column and which I give it in my *Mental Development*—on the Preformist view. I have argued briefly for this indifference to the particular theory one holds of heredity, in my book (Chap. VII.), reserving for a further occasion certain arguments in detail based upon the theory of the individual's personal relation to his social environment. The main point involved, however, may be briefly indicated now, although, for the details of the social influences appealed to, I must again refer

*This table is given in the issue of SCIENCE for July 26, p. 100. The three points from it which are taken up now are cited below.

to my book (Chaps. on 'Suggestion' and 'Emotion').

I have there traced out in some detail what other writers also have lately set in evidence, *i. e.*, that in the child's personal development, his ontogenesis, his life history, he makes a very faithful reproduction of his social conditions. He is, from childhood up, excessively receptive to social suggestion; his entire learning is a process of conforming to social patterns. The essential to this, in his heredity, is excessive instability, cerebral balance and equilibrium, a readiness to overflow into the new channels which his social environment dictates. He has to learn everything for himself, and in order to do this he must begin in a state of great plasticity and mobility. Now, my point, but briefly, is that these social lessons which he learns for himself take the place largely of the heredity of particular paternal acquisitions. The father must have been plastic to learn, and this plasticity is, as far as evidence goes, the nervous condition of acute consciousness; the father then learned, through his consciousness, from his social environment. The child does the same. What he inherits is nervous plasticity and the consciousness. He learns particular acts for himself; and what he learns is, in its main line, what his father learned. So he is just as well off, the child of Preformism, as if he had been the heir of the particular lessons of his father's past. I have called this process 'Social Heredity,' since the child really inherits the details; but he inherits them from society by this process of social growth, rather than by direct natural inheritance.

To show this in a sketchy way, I may take the last three points which Professor Cope makes under the Epigenesis column, the points which involve consciousness, and show how I think they may still be true to the Preformist if he avail himself of the resource offered by 'Social Heredity.'

I do this rather for convenience than with any wish to controvert Professor Cope; and it may well be that his later statements may show that even this amount of reference to him is not justified.

1. (5 of Cope's table.) "Movements of the organism are caused or directed by sensation and other conscious states."

The point at issue here between the advocate of Epigenesis and the Preformist would be whether it is necessary that the child should inherit any of the particular conscious states, or their special nervous dispositions, which the parent learned in his lifetime, in order to secure through them the performance of the same actions by the child. I should say, no; and for the reason—additional to the usual arguments of the Preformists—that 'Social Heredity' will secure the same result. All we have to have in the child is the high consciousness represented by the tendency to imitate the parent or to absorb social copies, and the general law now recognized by psychologists under the name of Dynamogenesis—*i. e.*, that the thought of a movement tends to discharge motor energy into the channels as near as may be to those necessary for that movement.* Given these two elements of endowment in the child, and he can learn anything that his father did, without inheriting any particular acts learned by the parent. And we must in any case give the child this much; for the principle of Dynamogenesis is a fundamental law in all organisms, and the tendency to take in external 'copies' by imitation, etc., is present in all social animals, as a matter of fact.

The only hindrance that I see to the child's learning everything that his life in society requires would be just the thing that the advocates of Epigenesis argue for —the inheritance of acquired characters. For such inheritance would tend so to bind

* Both of these requirements are worked out in detail in my book.

up the child's nervous substance in fixed forms that he would have less or possibly no unstable substance left to learn anything with. So, in fact, it is with the animals in which instinct is largely developed; they have no power to learn anything new, just because their nervous systems are not in the mobile condition represented by high consciousness. They have instinct and little else. Now, I think the Preformist can account for instinct also, but that is beside the point; what I wish to say now is that, if Epigenesis were true, we should all be, to the extent to which both parents do the same acts (as, for example, speech) in the condition of the creatures who do only certain things and do them by instinct. I should like to ask of the Neo-Lamarckian: What is it that is peculiar about the strain of heredity of certain creatures that they should be so remarkably endowed with instincts? Must he not say in some form that the nervous substance of these creatures has been 'set' in the creatures' ancestors? But the question of instinct is touched upon under the next point.

2. (6 of Cope's table.) "Habitual movements are derived from conscious experience." This may mean movements habitual to the individual or to the species in question. If it refers to the individual it may be true on either doctrine, provided we once get the child started on the movement—the point discussed under the preceding head. If, on the other hand, habitual movements mean race movements, we raise the question of race habits, best typified in instinct. I agree with Mr. Cope that most race habits are due to conscious function in the first place; and making that our supposition, again we ask: Can one who believes it still be a Preformist? I should again say that he could. The problem set to the Preformist would not in this case differ from that which he has to solve in accounting for development generally: it would not be altered by the postulate that consciousness is present in the individual. He can say that consciousness is a variation, and what the individual does by it is 'preformed' in this variation. And then what later generations do through their consciousness is all preformed in the variations which they constitute on the earlier variations. In other words, I do not see that the case is made any harder for the Preformist by our postulate that consciousness with its nervous correlate is a real agent. And I think we may go further and say that the case is easier for him when we take into account the phenomena of Social Heredity. In children, for example, there are variations in their mobility, plasticity, etc.; in short, in the ease of operation of Social Heredity as seen in the acquisition of particular functions. Children are notoriously different in their aptitudes for acquiring speech, for example; some learn faster, better, and more. Let us say that this is true in animal communities generally; then these most plastic individuals will be preserved to do the advantageous things for which their variations show them to be the most fit. And the next generation will show an emphasis of just this direction in its variations. So the fact of Social Heredity—the fact of acute use of consciousness in ontogeny—becomes an element in phylogeny, also, even on the Preformist theory.

Besides, when we remember that the permanence of a habit learned by one individual is largely conditioned by the learning of the same habits of others (notably of the opposite sex) in the same environment, we see that an enormous premium must have been put on variations of a social kind—those which brought different individuals into some kind of joint action or coöperation. Wherever this appeared, not only would habits be maintained, but new variations, having all the force of double he-

reditary tendency, might also be expected. But consciousness is, of course, the prime variation through which coöperation is secured. All of which means, if I am right, that the rise of consciousness is of direct help to the Preformist in accounting for race habits—notably those known as gregarious, coöperative, social.

3. (7 of Cope's table.) "The rational mind is developed by experience, through memory and classification." This, too, I accept, provided the term 'classification' has a meaning that psychologists agree to. So the question is again : Can the higher mental functions be evolved from the lower without calling in Epigenesis? I think so. Here it seems to me that the fact of Social Heredity is the main and controlling consideration. It is notorious how meagre the evidence is that a son inherits or has the peculiar mental traits of parents beyond those traits contained in the parents' own heredity. Galton has shown how rare a thing it is for artistic, literary or other marked talent to descend to the second generation. Instead, we find such exhibitions showing themselves in many individuals at about the same time, in the same communities, and under the same social conditions, etc. Groups of artists, musicians, literary men, appear, as it were, a social outburst. The presuppositions of genius—dark as the subject is—seem to be great power of learning or absorbing, marked gifts or proclivities of a personal kind which are not directly inherited but fall under the head of sports or variations, and then a social environment of high level in the direction of these sports. The details of the individual development, inside of the general proclivity which he has, are determined by his social environment, not by his natural heredity. And I think the phylogenetic origin of the higher mental functions, thought, self-consciousness, etc., must have been similar. I have devoted space to a detailed account of the social factors involved in the evolution of these higher faculties in my book.

I fail to see any great amount of truth in the claims of Mr. Spencer that intellectual progress in the race requires the Epigenesis view. The level of culture in a community seems to be about as fixed a thing as moral qualities are capable of being; much more so than the level of individual endowment. This latter seems to be capricious or variable, while the former moves by a regular movement and with a massive front. It would seem, therefore, that intellectual and moral progress is gradual improvement, through improved relationships on the part of the individuals to one another ; a matter of social accommodation, rather than of natural inheritance alone, on the part of inindividuals. It is only a rare individual whose heredity enables him to break through the lines of social tissue and imprint his personality upon the social movement. And in that case the only explanation of him is that he is a variation, not that he inherited his intellectual or moral power. Furthermore, I think the actual growth of the individual in intellectual stature and moral attainment can be traced in the main to certain of the elements of his social *milieu*, allowing always a balance of variation in the direction in which he finally excels.

So strong does the case seem for the Social Heredity view in this matter of intellectual and moral progress that I may suggest an hypothesis which may not stand in court, but which I find interesting. May not the rise of the social life be justified from the point of view of a second utility in addition to that of its utility in the struggle for existence as ordinarily understood, the second utility, *i. e.*, of giving to each generation the attainments of the past which natural inheritance is inadequate to transmit? Whether we admit Epigenesis or

confine ourselves to Preformism, I suppose we have to accept Mr. Galton's law of Regression and Weismann's principle of Panmixia in some shape. Now when social life begins we find the beginning of the artificial selection of the unfit; and so these negative principles begin to work directly in the teeth of progress, as many writers on social themes have recently made clear. This being the case, some other resource is necessary besides natural inheritance. On my hypothesis it is found in the common or social standards of attainment which the individual is fitted to grow up to and to which he is compelled to submit. This secures progress in two ways: First, by making the individual learn what the race has learned, thus preventing social retrogression, in any case; and second, by putting a direct premium on variations which are socially available.

Under this general conception we may bring the biological phenomena of infancy, with all their evolutionary significance: the great plasticity of the mammal infant as opposed to the highly developed instinctive equipment of other young; the maternal care, instruction and example during the period of helplessness, and the very gradual attainment of the activities of self-maintenance in conditions in which social activities are absolutely essential. All this stock of the development theory is available to confirm this view.

And to finish where we began, all this is through that wonderful engine of development, consciousness. For consciousness is the avenue of all social influences.

J. MARK BALDWIN.

PRINCETON.

## THE SCIENCE OF EXAMINING.

MUCH severe criticism is being directed against examinations, and much of it is timely and fully deserved. And yet when the criticisms are carefully considered they appear to be directed not so much against examinations as a method in education as against certain forms of examination which are very prevalent and which certainly do not show anything more than evanescent memorization, adroitness or trickiness on the part of a student. No one will deny, however, that much of actual life is a kind of examination, and that we are being continually pressed to solve problems of all kinds, apply knowledge, and in general to act, and that on the success of our efforts will depend the positions we will attain, or, at least, maintain. There seems to be no reason why examinations should not be made an extremely important part of education, instead of being, as I fear they often are, an unmitigated nuisance to both student and teacher, a bone for the pedagogical critics continually to snarl over, and, when all is done, to be of no real use to either teacher or student, and to show nothing as to the real nature of the teaching done and the mental development of the student.

For the teacher who teaches from love of teaching, and who knows that successful teaching calls for the application of psychological principles far more than is generally supposed, there is a peculiar fascination in an examination paper. An examination may be made a test of the contents, capacity, quality and action of a mind under defined conditions; but the paper must be a good one; I do not refer to the work of an inexperienced hand. The idea seems to be prevalent that anyone can write an examination paper. This is a great mistake. The elaboration of a paper that will really test not only the contents of the mind, but also its different functions as developed by a particular study under the guidance of a particular teacher, requires experience and ability. It is true that a man may be a good teacher and a poor examiner, but this usually arises from a lack of attention to the science and art of examining. My ex-

perience in this branch of pedagogical science leads me to believe that there are not very many really good examiners, and that the average examinations do not test the minds of the student as they ought to be tested. The average examination calls mainly for an exercise of memory, and for some proof that the student understands the matter he has studied. No man values the faculty of memory more highly than I do, or requires a better understanding of a given subject. But memory and mere understanding are only the foundations of education. More than this is called for. Some examinations require skill in observation, others accurate definition; while others bristle with problems. Some call for knowledge in which the teacher is weak. Almost every pedagogic earmark may be found in examination papers, but rarely is the paper constructed on such a plan that it tests not only the quality and quantity of knowledge in the mind, but also the various workings of the mind, and ascertains what the mind can do when set in action by the particular subject.

In my own specialty of chemistry there is an excellent opportunity for examination papers, which may test the mind qualitatively and quantitatively, and probe both absorptive and productive powers. I have always taken a great interest in working out examination papers and in studying the minds as they appear in the answers. I am accustomed to work out questions under various heads. The following examples will serve to indicate my meaning, and may also encourage others to experiment in examinational science ; and I think that the method will be found so interesting that the investigation will not be hastily dropped. I should add that in the examination paper as given to the students the questions are mixed up, so that the classifications given as follows do not appear.

QUESTIONS FOR TESTING:—

*Memory.*—(1) Give a brief history of oxygen. (2) Outline the theory of phlogiston. (3) What are 'copperas;' 'bluestone,' 'tincal.'

*Accuracy of Definition.*—(4) State concisely the laws of Dalton, Charles, Mariotte and Avogadro. (5) Define a mechanical mixture. (6) Define an element.

*Observation of Experimentally Demonstrated Facts.**—(7) Describe and sketch an apparatus for producing acetylene from calcium carbid and explain the working of it. (8) Describe and sketch the combustion of nitric acid in iodohydric acid.

*Accuracy of Detail.*—(9) Explain with the aid of sketches the reduction of hot cupric oxid by hydrogen, heating the oxid in a combustion-furnace and preparing the hydrogen in a Kipp generator.† (10) Make a sketch of a section of Pepy gasometer, and explain how the apparatus works.

*Acquaintance with the Properties of Matter.*—(11) Describe the properties and chemical behavior of nitrogen, sulfur, zinc, silica and iodin.

*Retention of Oral Instruction.*—(12) Explain the contamination of water by sewage. (13) Describe the process for making open hearth steel.

*The Faculty of Comparison.*—(14) State similarities and differences between the properties of oxygen and hydrogen. (15) What substances resemble lead sulfid in color and solubility in nitric acid.

*Lucidity of Statement.*—(16) Describe minutely and without sketches the apparatus and method of preparing phosphine. (17) Prove by analysis of stibine by volume that the molecule of antimony is tetratomic.

*Recognition of Substances.*—(18) A yellowish green gas with a suffocating odor. What may it be? (19) A colorless gas, very soluble in water, gives white fumes with hydrochloric acid. What may it be? (20) A white powder, insoluble in water; heated with concentrated nitric acid it evolves red fumes and yields a solution, which, when excess of acid is evaporated off, and it is diluted with water, yields a precipitate which is insoluble in concentrated nitric acid. What may this white substance be? (21) A chemist wishes to fill a jar with red liquid. What substance may he use?

*The Ability to Observe.*—(22) Give four examples of chemical change which you observe in this room. (23) Describe an ordinary red building brick, stating dimensions and properties of surface, weight, fracture, etc. (24) Water expands on freezing. Give five examples of results caused by this expansion which you have personally observed.

* Given in lectures and not in text-book.

† Given in text-book and demonstrated in lecture.

*The Application of Facts to Proofs.* (25) Prove that water is formed by the combustion of a kerosene lamp. (26) Prove that hydrogen sulfid contains sulfur.

*The Interpretation of Phenomena.*—(27) A piece of white paper on being held for an instant in the flame of a candle and at right angles to it, a black ring is formed on the paper. Explain what the ring indicates, and how the particles of carbon are formed and why they are deposited on the paper. (28) A Roman candle on being ignited and then thrust under water continues to burn. How can this be accounted for? (29) Why cannot fish live in lakes on the tops of very high mountains.*

*The Application of Knowledge.*—(30) The iodin falls into the sand box. How can the iodin and sand be separated? (31) A mixture consists of barium carbonate, sodium sulfate and sulfur. How can they be separated? (32) A manufacturer has a waste product consisting of a liquid containing 40 % of sulfuric acid, 10 % sodium sulfate and 5 % ferric sulfate. How can he treat it so as to convert it into other products that have commercial value?

*Deceptive or Misleading Questions.*—(33) Dilute sulfuric acid is poured upon zinc. A gas with a slight bluish* color is evolved which burns with a red† flame. What is it? (34) Chlorin gas is collected in a jar over mercury‡ in the usual manner. It is then brought into a eudiometer, mixed with twice§ its volume of hydrogen, and exploded. How many volumes of hydrochloric acid gas will be produced?

*The Imagination.*—(35) Filthy water of the gutter, warmed by the sun's rays, escapes from a foul environment, and, condensing, sparkles like diamonds on the petal of the violet. Use this as basis for an allegory in life.

These questions do not by any means represent all the possible divisions of mental action, and I have purposely avoided those of a very technical nature, most of which, however, would fall under the heads given; but they will serve to indicate what opportunities there are to construct examination papers that shall test a student's knowledge and the working of his mind. It may be urged against the questions I have given that several of them might fall as well under one head as another, or that a few more elaborate questions could be made out and each question marked under the several heads. My experience, however, has not been that the real ends are best attained in this way. The question that is distinguished by its definite nature and object gets a clearer answer and gives a more satisfactory insight into the student's mental equipment and action than a long or complicated one. If, after teaching a student a subject for a certain time, an examination shows that he can bring forth nothing more than that which has been put into him, it may be inferred either that the teacher is incompetent, or that the student is intellectually deficient; assuming, of course, that the system in the particular institution permits the teacher to do his best, does not assign him more pupils than one man can teach, and requires the student to do the work assigned to him. In such case I think that the fault usually lies with the teacher. Still I admit that there are institutions in which educational work of a high pedagogical order is impossible, and mind development, as distinguished from mind cramming, is out of the question. In such a case students are produced who are saturated with knowledge, but who are incapable of utilizing it. Like water-logged vessels they roll about aimlessly, and are unable even to keep out of the way of craft which are taking the fullest advantage of wind and tide. In such an institution the earnest teacher, when he fails, deserves sympathy more than blame.

The results of examinations, conducted on some plan like the one I have attempted to describe, are very interesting. Such examination papers are far more difficult to write than the calls for mere memorization that are so frequently made on the student, and which a hasty cram will enable a fairly bright candidate to pass. The answers are

* Compare London University Matriculation Examinations, Stoker and Hooper, p. 31. Q. 6.

† Colorless.

‡ Chlorin cannot be collected over mercury.

§ Once.

more difficult to rate; and often an attempt to mark them according to the usual rules is unsatisfactory. It is quite easy to assign a mark to the amount that a student knows, or even to discriminate as to the quality of his knowledge. To assign a figure to his ability to apply this knowledge, to originate, to create, to act under its instigaton, is more difficult; yet it can be done with a fair degree of success.

It must always be borne in mind that a man's value in this life does not depend merely on what he knows, but upon what he can do. *Cœteris paribus*, the more he knows, the more he should be able to do; for so much the greater should be the incentive, if the knowledge imparted to him acts on him as it should. Until technical education was introduced, this fact was not well understood, and it is still far from appreciated in many schools.

For instance: A shows in his paper an encyclopedic knowledge. In his answer to Q. 11 he recites with great precision the properties of silica and iodin. But he fails to answer Q. 30, which calls for a conclusion dependent upon this knowledge. He is like a recruit who has been given a gun, but has not been taught how to fire it off. Such a student demands the teacher's attention at once. His mental inaction is usually the result of poor teaching.

It may not be amiss for me to say parenthetically here that teaching is the most difficult of all professions. It is not usually regarded so, but I believe that it is. Much of what is called teaching is nothing more than a kind of pumping. Knowledge is forced in through the most convenient intellectual orifice, a great deal being lost *in transitu*, and not a little leaking out afterwards. The engorged recipient is like a boiler whose feed pump is too big for it and will not cease pumping, but fills the boiler entirely full of water and leaves no space for steam; whereon the engine slows down and stops, or throbs soggily with its cylinder filled with lukewarm water instead of hot expansive steam.

Again, a student may fail in his attempts to state anything correctly or exactly; but he fills pages with attempts to apply his knowledge, suggesting all sorts of ideas and applications. Most of them may be impossible, some even ridiculous. But no matter, let the teacher take hold of this boy at once, for the mind of an Edison, a Siemens or an Ericsson may be seeking nourishment and development. Happy is the teacher who can discern what mean the instinctive strugglings of the embryonic master mind, and who can liberate it from the thralldom of routine—who can guide its first weak attempts to walk and climb, until it becomes hardy and venturesome, and fearlessly scales cliffs heretofore inaccessible; and so clambering by hitherto unknown ways to the peak discovers new fields for human activity, and cuts a wide path by which thousands may enter and take possession.

What man gets closer to the Creator than the teacher, who can discern and understand His idea as shown in the youth and who clears away the obstacles in the way of its development, nourishes it until it is strong and independent, and itself becomes creative? Verily such a teacher has his reward.

Examination papers constructed on the basis I have suggested, viz.: to test not only the knowledge possessed by the student, but also the working of his mind upon the particular subject, will show more clearly the nature and condition of a mind than the daily recitation, because the case is more capable of systematic study and can be made to cover larger fields of mental activity. While I do not intend to suggest that such examinations should replace the regular recitation, I believe that they should be held frequently, and should serve a far wider purpose than that of merely

noting the quantity of knowledge absorbed by the mind. Such an examination is not a mere matter of testing and registering—it is a creative exercise of the mind.

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### *THE 'NEW RACE' IN EGYPTIAN HISTORY.*

DURING the session of the International Geographical Congress, Professor Flinders Petrie invited a number of the members to visit the extraordinary collection of Egyptian antiquities exhibited at the University College, the results of his excavations between Ballas and Nagada in the early months of 1895. They may well be called 'extraordinary,' as they introduce an entirely new element into the history of ancient Egypt, proving the presence on the Nile 'of a fresh and hitherto unsuspected race, who had nothing of the Egyptian civilization,' to quote Professor Petrie's words. Not that they were uncivilized. Far from it. Their culture was in some respects superior to that of the Egyptians of their age; but it was wholly independent of it, developed in another center, under an entirely different inspiration and technique, proving it the product of another ethnic group.

These intruders overthrew the great civilization of Egypt at the close of the VIth dynasty, and were in turn overthrown by the rise of the XIth dynasty at Thebes. In the current chronology this would place them from 3300 to 2800 B. C. They completely expelled or destroyed the former inhabitants for more than a hundred miles along the Nile Valley, in the district situate between Gebelen and Abydos. How thoroughly they extirpated their predecessors in this region may be judged by the fact that, in opening over two thousand of their graves and examining several of their town sites, not a single Egyptian object was found. Nor did they care to learn any Egyptian art; for though they worked extensively and skilfully in clay, all their vessels are made by hand, and they refused to adopt the potter's wheel, which was then and long before familiar to the Egyptians. They brought with them a culture belonging to the highest neolithic type. I have never seen in any other collection, flint implements of equal finish or so graceful in outline. Beautifully polished beads and small ornaments of cornelian, amethyst, turquoise, garnet and other hard stones were found in abundance. Stone vases were shown in great variety and of graceful outlines.

The decorative designs are often elaborate, some in conventional lines, spirals and network, some representing boats, birds, trees and human beings. Animal designs in relief are portrayed with artistic consciousness.

Of metals, copper was the only one in frequent use. Adzes, needles, harpoons and daggers were manufactured from it.

Their mode of interment was altogether unknown to the Egyptians. The bodies were buried in the gravel, not in rock tombs. The graves were square pits, and the corpse was laid in a contracted position with the head to the south and the face to the west. The custom of incineration did not prevail; but there are signs of funereal human sacrifices, and apparently of cannibalism.

It is not likely that they shared the Egyptian's skill in architecture. Two of their towns which were examined showed remains of structures of mud brick of small size.

What were the ethnic relations of these mysterious invaders, this 'new race,' as Professor Petrie called them?

In the interesting address which he made to us on the occasion of our visit, he expressed himself cautiously but with a positive conviction. From numerous analogies

of culture, of cranial forms, of geographic position, of historic references, he had been led to the conviction that they belonged to the Berber or Libyan groups, that vast ethnic stock which occupied the whole of north Africa, west of the Nile Valley, above the Soudan. His arguments seemed to myself and others quite sufficient, at least in the present stage of the investigation.

What is especially noteworthy is the fact that civilization was highest on their arrival. Later it degenerated, and finally became absorbed in the Egyptian. Therefore, if Professor Petrie is right in his identification, we must credit to the Numidian-Libyan tribes of the fourth millenium B. C. a culture of native growth higher in many respects (though inferior in others) to that of the Egyptians who were their contemporaries.

Of the many and brilliant discoveries we owe to the indefatigable zeal of Professor Petrie, this last, of which I give this cursory account, is perhaps the most important for the history and ethnography of the Nile Valley and northern Africa.

D. G. BRINTON.

LONDON, Aug. 3.

## *CURRENT NOTES ON PHYSIOGRAPHY (XIV.).*

### FOUREAU'S EXPEDITION INTO THE SAHARA.

FOR the third time, Foureau has been repulsed by the Touaregs in his attempt to cross the desert and reach the inland district of Air. The nomads resent the intrusion of European explorers, and do not wish to hear of commerce or trans-Saharan railways. Although not an expert in geographical description, Foureau's account of his unfortunate expedition gives many interesting sketches of the *hammada*, or rugged sandstone uplands, too stony for camels to cross; the *erg*, or sandy areas of the lower lands, with chains of dunes trending N. E. –S. W., as if controlled by the trade winds; the numerous *wadies*, or stream courses, universally adopted as routes of travel, although caravans are here sometimes overwhelmed by floods from which there is no escape where the walls are steep. Gently sloping plateaus (hammada), dissected by long consequent valleys to the north and broken by short and steep obsequent streams on their south-facing escarpments, are characteristic features of the regions south of Wargla, in latitude 27°. Much of the surface near the wadies is minutely dissected, and would be called 'bad lands' by our Western explorers. The barrenness of the stony plateaus is complete; but along the wadies there are acacias and scattered herbage on which horses and sheep find a scanty pasture. A little wheat is raised on the flood plains. Swarms of grasshoppers sometimes consume the vegetation. The people are excessively poor, and all are great beggars, clamoring for gifts. In November, 1893, minima of –6° C. were recorded several times; sleeping without a tent, the explorer's blanket was covered with frost nearly every morning. Although suffering from cold, Foureau found, on the other hand, plenty of water in pools along the wadies, for in the five winter months of 1893–'94 there was rain on twenty-two days. Snow was seen on the plateaus. On several mornings there was dense fog. The Touaregs thought the cold spell was brought by the explorers. Moufflons were seen on the hammadas, and antelopes were common on the erg districts (Bull. Soc. géogr., Paris, XVI., 1895, 10–74).

### LACCOLITIC MOUNTAIN GROUPS.

THE fourteenth annual report of the United States Geological Survey contains an interesting chapter on the laccolitic mountain groups of Colorado, Utah and Arizona, by Whitman Cross. It serves as an extension of the report on the Henry mountains by Gilbert of some years ago. While the chief value of this chapter is in

its discussion of structural and petrographical problems, it is of use to the physiographer also in giving excellent description and illustration of typical examples belonging to this peculiar member of the volcanic group of forms. It may thus serve as a corrective to the undue share of attention ordinarily allowed to the superficial loose-textured and short-lived volcanic cone. It serves also to enforce the idea that the surface of the land as we see it is often deeply carved in land of earlier times; truly a primitive geological conception, but one which geographers have been slow to recognize and utilize.

### THE RUN-OFF OF RIVERS.

THE same report of the survey contains a chapter by F. H. Newell on the results of stream measurements, in which an important relation is indicated between rainfall and topography, on the one hand, and 'run-off,' on the other. For example, where the mean annual rainfall on mountainous regions is 40 inches, the run-off approaches 30 inches; where the rainfall is 25 inches, the run-off is 15; where the rainfall is 12, the run-off is only 5. On more open country, where the mean annual rainfall is 50 inches, a run-off of 25 inches may be expected; where the rainfall is 30 inches, the run-off is about 8 inches; while where the rainfall is 20 inches, only about 3 inches gets into the streams. In both mountainous and open country, the percentage of run-off rapidly decreases as the rainfall lessens. One notable exception to this rule is noted. In regions of small rainfall, under twelve inches, the rain usually falls at long intervals, but then at an excessive rate, often as 'cloud bursts.' In such cases the water has little time to penetrate the ground, and the run-off is exceptionally large. An interesting map of the mean annual run-off of our country accompanies this essay.

W. M. DAVIS.

HARVARD UNIVERSITY.

## *SCIENTIFIC NOTES AND NEWS.*

### THE BRITISH MEDICAL ASSOCIATION.

THE sixty-third annual meeting of the Association convened in London on July 30th, with an attendance of nearly 3000 members. The growth of the Association in recent years has been remarkable. When it last met in London (1873) the membership was 1500, whereas now it is the strongest medical society of the world, having 15,669 members and property of great value. The address of the president, Sir J. Russell Reynolds, was entitled 'The power of life in life,' and discussed in part the use of 'living things' in the conservation of health and the prevention or cure of disease. The address also reviewed the progress of medicine since the preceding London meeting and the relations of professional life to certain aspects of art and religion. The Association met in fifteen sections, before each of which many papers were presented, followed by discussions of much interest, not only to members of the medical profession, but also to all interested in the progress of science. The Association occupies somewhat the position of a professional trades union, and with its great membership and means and its organ, *The British Medical Journal*, is able to influence, not only the etiquette and practice of the profession, but also legislation. The reports of committees, such as that on Parliamentary bills, and the discussions that followed, were consequently of great practical importance.

### SECTION C, CHEMISTRY, OF THE A. A. A. S.

THE committee appointed by the Council to prepare a programme for the meetings announce that the Committee after careful consideration believe that added interest may be given to the meetings by providing, in addition to the original papers that may be offered, a series of discussions of subjects of current interest to chemists, in

which all who may be present may take part. In order that a systematic course may be followed in these discussions, each general division of chemical work arranged for this meeting will be introduced by a member of the section, who will be followed in turn by some other members who may have anything to offer. These discussions will be open to all members of this Section, but it is requested that those who may have something to offer will advise the Chairman of the Committee of the fact and submit to him as early as possible a brief abstract or syllabus of the material. The object of this is to enable the Committee to make a systematic arrangement of the work to be done. The several sessions will be devoted respectively to physical, general inorganic, general organic, analytic, didatic, biologic, hygienic, agricultural and technical chemistry. The address of the vice-president, Dr. William McMurtrie, is on 'The Relations of the Industries to the Advance of Chemical Science.'

### THE BOTANICAL SOCIETY OF AMERICA.

THE Botanical Society of America was formally organized last summer at Brooklyn. The first annual meeting will be held at Springfield, Mass., Tuesday and Wednesday, August 27th and 28th, immediately preceding the meeting of the A. A. A. S. The sessions of the Society will be held in the High School building, room 6, first floor, beginning at 3 P. M., Tuesday. The Council will meet at the Hotel Worthy at 2 P. M. of the same day, for the purpose of arranging the program and for such other business as may come before it.

C. R. BARNES, *Sec'y.*

### VITAL STATISTICS OF NEW ENGLAND.

A SUMMARY of the vital statistics of the New England States for the year 1892 has been compiled under the direction of the secretaries of the State Boards of Health and published by Damrell & Upham, Boston. It appears that the birth rate of New England, 24.9 per thousand of the population, was less than that of any European country excepting France and Ireland. The death rate (19.9) was less than that of Italy, Hungary, Austria, Germany, France, Holland and Belgium, but greater than that of the British Islands, the Scandinavian countries and Switzerland. The marriage rate (18.5) was higher than that of any other country. The illegitimate births were only 13.4 per thousand living births, whereas in Europe they vary from 25 in Ireland to 143 in Austria. The total population of New England (4,700,745) is almost equally divided between the urban population contained in cities having a population larger than 10,000 and the rural population. The marriage, birth and death rates in the two groups were as follows:

| | Marriage. | Birth. | Death. |
|---|---|---|---|
| Urban Group ........... | 20.66 | 29.68 | 21.01 |
| Rural Group ............ | 16.42 | 20.00 | 18.72 |

### GENERAL.

AT the *Versammlung deutscher Naturforscher und Aerzte*, which will be held in Lübeck, under the presidency of Professor J. Wislicenus, from the 16th to the 21st of September, the following lectures will be given: On Some Problems of the Physiology of Reproduction, by Professor G. Klebs; Serum Therapeutics, by Professor Behring; Surgical Operations on the Brain, by Professor Riedel; Atomic Problems, by Professor Victor Meyer; Neo-Vitalism, by Professor von Rindfleisch; The Origin of the East Sea, by Professor R. Credner; The Overthrow of Scientific Materialism, by Professor W. Ostwald.

ACCORDING to the *Naturwissenschaftliche Rundschau*, the 'Göttingen Gesellschaft der Wissenschaften' offers a prize of 500 marks, to be awarded February 1, 1897, for an anatomical research and description of the cavities of the body of the new-born child and their contents compared with those of the adult. The Academy of Sciences of Cracow proposes, as subject for the Copernicus prize (1000 and 5000 fl.), theories concerning the physical condition of the globe. The essays must be received before the end of December, 1898, and must be written in the Polish language.

The Annual Congress of the British Institute of Public health was held at Hull, on August 8th to 13th.

MR. ADOLPH SUTRO, Mayor of San Francisco, has offered to the Regents of the University of California thirteen acres of land on which to erect buildings for the affiliated colleges of the University. In addition he offers to deed to the trustees of the city thirteen acres adjoining as a site for the Sutro Library. The collection of books is said to contain 200,000 volumes, and the total value of gifts to be $1,500,000.

MR. GRANT ALLEN has written *The Story of the Plants* for Appleton's Library of Useful Stories.

THE Japanese government has made an appropriation for the laboratory of Dr. Kitasato, in which researches of great importance are now in progress on the cause of leprosy.

AT a conference on the deaf and dumb held recently at Exeter Hall, London, a constitution for a new national association was adopted. Among other addresses was one by Mr. J. N. Bannerji on the position of the 200,000 deaf mutes in India, the education of whom is unassisted by the government. The following resolutions were passed: "That it is desirable that facilities should be given by which pupils of our institutions who show exceptional ability should have the advantage of a more extended education than it is now possible to give them." "That this conference considers it desirable that the governing bodies of institutions should at once petition the government to reduce the proportion of one-third, to be provided out of sources other than rates of moneys provided by Parliament, to the proportion of one-fifth." "That the committee of the National Association of Teachers of the Deaf be requested to draft at the earliest possible opportunity a scheme of education for children of school age as a suggestion to the Education Department."

THE 100th anniversary of the foundation of the Institute of France will be celebrated an October 23d, 24th and 25th with appropriate ceremonies.

THE Chemical Industry Society, an English society devoted to the study and practise of applied chemistry, with a membership of 2892, held its annual meeting at Leeds during the first week in August.

THE 'Berliner Akademie der Wissenschaften' has recently appropriated over $5000 for the promotion of scientific work and research. Among others we may mention an appropriation of 2000 Mk. to Professor Fuchs, of Berlin, to be devoted to the continuation of the publication of Dirichlet's works; 2000 Mk. to Professor Weierstrass, of Berlin, for the publication of his collected works; 1500 Mk. to Professor Gerhardt for the publication of the Mathematical correspondence of Leibnitz, and 2000 Mk. to Dr. Schauinsland for researches on the Fauna of the Pacific islands.

THE Steward Prize of the British Medical Association for 1895, consisting of an illuminated address and a cheque for £50, was awarded to Brigade-Surgeon-Lieutenant-Colonel D. Douglas Cunningham, M. B., C. I. E., F. R. S., for his bacteriological

work in India, especially in the investigation of the bacillus of cholera.

THE chief article in the June number of the 'Quarterly Journal of Microscopical Science' is a study of Metamerism by Prof. T. H. Morgan, of Bryn Mawr College, in which he treats, on the basis of a large amount of original research, irregularities in the serial repetition of rings of annelids.

IT has been shown in a report of the subcommittee of the Glasgow corporation that some samples of French peas examined contain fifteen grains of copper sulphate in the pound. The French government forbids the use of these peas in France, but allows them to be exported.

THE exhibition of the Department of Mines at the Cotton States and International Exposition will include four oil paintings 120 feet long, showing sections of the Appalachian range of mountains drawn on the scale of one foot to a mile. In these paintings every mineral and coal vein in in the Appalachian system will be shown. Sections from the different coal veins of the United States will be exhibited, some of these sections weighing seven tons and showing the whole vein. The exhibition is personally superintended by Dr. David T. Day, Chief of the Department of the Government Board of the Exposition.

GINN & Co. announce for publication this summer 'Lakes of North America,' by Professor Israel C. Russell. The origin of the lake basins and their place in topographic development, the movements of lake waters, the topography of lake shores, the relation of lakes to climatic environment, the life histories of fresh and of saline lakes, are some of the subjects discussed.

THE British Museum has recently published the accounts of the income and expenditure of the 'Special Trust Funds' for 1895. These are six in number, amounting to £24,177, of which the interest is £1,518. This has been expended on salaries, the purchase of manuscripts and excavations in Cyprus. The number of visitors to the museum in 1894 was 578,977. An average of 670 daily visit the reading rooms for purposes of research and reference. 413,572 people were admitted to the collections of the Natural History department; of these 20,029 were students, chiefly in the department of zoölogy.

DURING the year a valuable collection of Hindu coins has been bequeathed to the museum by the late Sir Alexander Cunningham, and a large collection of Turkish books published in Constantinople during the reign of the present Sultan, by whom the volumes were sent. The museum has also acquired a portion of the collection of rare English books of the period of Elizabeth and James I., discovered in 1867, at Lamport Hall, the seat of Sir Charles Isham, where they appear to have been forgotten for two centuries.

BY the will of Benjamin P. Cheny the sum of $50,000 was left to various public institutions. The Massachusetts Institute of Technology receives $10,000.

M. LUCIEN NAPOLEON BONAPARTE WYSE, a well-known engineer and explorer, died at Paris on August 12th, at the age of 51. He was a grandson of Lucien Bonaparte. He made extensive hydrographical and other scientific explorations, and in 1875 undertook the survey of the Panama isthmus. His "Rapport," 1876–78, on this survey was followed by the operations of M. de Lesseps on the Panama ship canal.

THE astronomer Andreas Löwald Pihl died in Christiania on July 1st, at the age of 73 years.

THE *Lancet* announces the deaths of Dr. S. Moos, professor of otology in Heidelberg; Dr. Kiener, professor of pathological anatomy in Montpellier, and Dr. Albert Nagel, professor of ophthalmology in Tübingen.

DR. ADOLF GERSTÄCKER, professor of zoölogy in the University of Greifswald, died on July 20th, at the age of 67 years.

DR. GUSTAV VON GROFE, professor of mathematics in the University of Dorpat, died recently at the age of 47 years.

MR. JOSEPH THOMPSON, one of the most distinguished and successful of modern African explorers, died on August 7th, at the age of 37.

## UNIVERSITY AND EDUCATIONAL NEWS.

FEW realize the great work done at the University of Kansas along scientific lines. To-day, as happens every summer, several expeditions are in the field collecting for the enrichment of the university museums and laboratories. Professor S. W. Williston is spending his second vacation in the Bad Lands of Wyoming. Last summer he returned to the University richly rewarded for his summer's work by valuable specimens which were described by him during the year in the Kansas University Quarterly. Also under his direction, but not personal supervision, a party has been at work in the cretaceous deposits of western Kansas and eastern Colorado. Professor E. Haworth has been constantly busy in directing the Geological Survey of the State; this work being done in connection with the State Irrigation Survey. Last summer Professor Haworth completed a stratigraphical survey of the southeastern portion of the State. L. L. Dyche, curator for the zoölogical museums, is with the Peary Relief Expedition as chief naturalist. Professor Dyche hopes to secure many valuable specimens of Arctic mammals. Last season Professor Dyche was with the party on board the ill-fated Miranda. He had secured a large amount of material, all of which was lost when the vessel went down. Another expedition which goes out each summer is that from the Department of Entomology. This season collections for this department are being made in northern Wyoming. Last year the summer was spent in New Mexico. But it is not alone in natural history that advances are being made. Along every other line work is being done. The physics and electrical engineering department has taken possession of the new building just completed which is to be devoted to the study of electricity. It is true that rare advantages are given the Kansas students of science in natural proximity to the great collecting regions of the west. But these rare advantages might have been allowed to remain undeveloped had not early in the history of Kansas a teacher been found who possessed in the highest degree the rare quality of being not only an enthusiast himself, but also a teacher capable of arousing enthusiasm in others. This teacher was Francis H. Snow, first professor of natural history, then professor of botany and entomology, and now Chancellor of the University. To him Kansas owes more than to any one man for the upbuilding of her great University. He laid the foundation for the great entomological collections now only second in size and value to those of Harvard; for the famous Kansas collection of mounted mammals; for the geological and paleontological museums, and for the excellent herbarium. But it is as Chancellor of the University that perhaps his most noticeable work has been done. Since 1890, when he was placed in the president's chair, the institution has doubled in size of equipment, number of students and power in the State. The standard of scholarship has been raised, and the University has been placed in the front rank of State Universities. X.

*The Botanical Gazette* states that on account of serious financial difficulties and a distrust of the progressive and enlightened educational policy of President John, the trustees of De Pauw University at Greencastle, Indiana, have forced the resignation of the president and set about a return to

the old paths. The department of biology having been founded by Dr. John was among the first to suffer. It was summarily abolished, the announcement being made without previous warning only the day before commencement. From a professor of zoölogy and one of botany at the beginning of the last college year, the instructional force is reduced to a single tutor, who is expected to give instruction in the elements of both sciences.

THE Board of Trinity College, Dublin, while declining to grant permission to women to attend lectures and examinations at the College, have offered, on certain conditions, to conduct examinations for special certificates.

THE Regents of the State University have voted to confer the university degree, M. D., only after one year's post-graduate study subsequent to receiving the degree of bachelor or doctor of medicine from some registered medical school, and only on candidates who have spent not less than four years' total study in accredited medical schools.—*Medical Record.*

PROF. J. W. JUDD has been appointed successor of Huxley as Dean of the Royal College of Science, South Kensington.

THE chair of surgery in the University of Breslau, vacant through the death of Prof. Trendlenburg, which was declined by Prof. Mikulicz, has now been offered Dr. Schede, of Eppendorf General Hospital, Hamburg.

DR. RUDOLF METZNER, of Freiburg, has been called to the chair of physiology in the University of Basel, in the place of Professor Miescher, who has retired.

DR. EMIL YUNG has been made professor of zoölogy and comparative anatomy in the University of Genf as successor to Karl Vogt.

DR. HANS PECHMANN has received a call to a professorship of chemistry in the University of Tübingen.

## *CORRESPONDENCE.*

### THE NEW BIBLIOGRAPHICAL BUREAU FOR ZOÖLOGY.

ON January 1st, 1895, there will be established in Zurich, Switzerland, an International Bibliographical Bureau for Zoölogy and comparative Anatomy. This Bureau is being organized on the broadest foundations and will be strictly international in character. There are already a number of committees in the more important countries of the world, and it is to be hoped that the organization will soon be entirely complete. In this country there is a committee nominated by the 'Society of Naturalists.' In France the organization is quite complete, and may serve as a model of what we still need in this country. In the first place there is an influential central committee in Paris.* In connection with this body is a corps, 'Associate Members.' The function of the 'Membres Associés' is to exercise direct local influence in such emergencies as require it. For example, it is proposed to issue an appeal to all publishing societies, asking them to send in to the central Bureau their publications for the purpose of recording the zoölogical observations which they contain. From the very outset of our undertaking it became evident that scientific societies would in general be glad to respond to such an appeal, but that there were considerable difficulties in the way of relying unconditionally upon this coöperation. A preliminary canvass was undertaken among the leading Paris societies, which showed conclusively that both learned societies and publishing firms were most willing to coöperate, but that they would have to have the matter properly brought to their notice by persons devoted to the movement; a mere general appeal might easily go unnoticed, and thus important works never reach the Bureau.

*See the 'Rapport de M. Bouvier, Mem. Soc. Zool. de France,' 1895, 1*er* fasc.

The 'Membres Associés' undertake to look after this matter and see that every publication of their district is brought to the knowledge of the Bureau. The 'Associés' are 21 in number, and have already promised to do all in their power to accomplish their mission.

In addition to the 'Associés,' there is a body of 'Correspondants' whose duty is to record such publications as are inaccessible in any Swiss or Leipzig library. The 'Correspondants' are *few* in number and are all persons able to give considerable time to the work. A number of competent persons have kindly offered to do both classes of work in this country, and we can at least assume that the same generosity will be shown by publishing societies and publishers.

It must be remembered that it is not proposed to depend wholly upon these agencies for obtaining the material on which the work of the Bureau will be based; but that this organization is to supplement the more ordinary means of consulting the literature, *i. e.*, use of large libraries. Not only will the Bureau have access to works in the Swiss and Leipzig libraries; it will also have at its disposition the library of the Zoological Station of Naples. This arrangement is due to the generous coöperation of Geheimrath Dohrn, who, in addition to making an annual appropriation towards the support of the Bureau, has offered to have sent through the Bureau those works of which we may stand in need.

In order to treat adequately the Bohemian, Hungarian, Polish and Russian publications, special 'Sub-bureaux' are being organized. In Russia this is being provided by the Russian National Committee and by Professor Mitrophanow, who has shown remarkable activity in this connection. In Gallicia similar steps have been taken by Professors Hoyer, Sr. and Jr., and a Subbureau will be organized at Krakow.

Turning now to the system of recording, let it be noted, at the outset, that the staff of the Bureau will consist of zoölogists rather than of librarians. This fact permits it to undertake a task of immense value to the investigator, viz.: that of basing the subject index upon the text of the memoirs, instead of upon the mere title. I do not need to dwell upon the value of this feature. The insufficiency of the title for such purposes is familiar to every worker. In a previous note, I have already given a case from my own personal experience, in which the titles were absolutely valueless to the bibliographer of the question I then had in hand. An idea of the defectiveness of our existing bibliographical means can readily be obtained by anyone who will take the pains to compare the bibliographies found at the end of a number of special memoirs with the lists given under the corresponding headings of the best of our present catalogues. The classification given by the Bureau will then be based upon the *text* and will use the individual observations—the paragraph—as a unit, and not the paper as a whole. Furthermore any incidental observations, though wholly different from anything in the title, would be brought out by the Bureau.

The publications of the Bureau will consist in two principal editions: (1) a fortnightly bulletin and (2) a card catalogue. The morphological titles will also be reprinted annually by the 'Zoologischer Jahresbericht,' and indexed according to authors. It would be desirable if some similar arrangement could be made for systematic zoölogy; but this has not been provided for. It was our hope that the 'Zoölogical Record' might be transformed, so as to form together with the 'Zoologischer Jahresbericht' a complete annual record for zoölogy, but it seems unlikely that its directors could accept such an arrangement. It must not be forgotten by those who have urged this upon us, that the Zoölogical Record is pub-

lished with considerable pecuniary loss, and that our Bureau is unable to offer any adequate guarantee that the loss would not be just as great, unless the guarantee of a continental publisher would suffice.

The Bulletin will be divided into a series of chapters, including 1, a general part, and 2, a division into systematic groups. Under each heading will be placed not merely such works as deal exclusively with the matter indicated, but also—as cross references—any papers containing incidental observations in regard to it.

The Cards will be issued simultaneously with the Bulletin and will be of the standard Library Bureau size. They will be essentially Author's Cards, but will also bear classificatory symbols of such nature that they can readily be placed in a subject index by persons unfamiliar with zoölogy. Three sets of symbols will be used, each indicating a distinct system of classification—systematic, morphological and faunistic—and all based upon a study of the text.

**MAURER, F.** XIII., 7.
**1894 b.** Die ventrale Rumpfmuskulatur der anuren Amphibien. **Morph. Jahrb., Bd. 22, p. 225–262, Taf. 6, 7.**
[Entwickelung — *Rana;* Anatomie — *Dactylethra, Ceratophrys, Bominator;* Vergleich mit Urodelen.]

It is proposed to receive eventually subscriptions to the cards relating to *limited topics*. A student of a special question could then be informed at once of the appearance of each publication touching his particular field, and thus be saved much of the mechanical labor of looking through the journals for the papers which interest him. For the present, however, larger divisions only of the catalogue can be so offered.

I have already spoken of the generosity of Geheimrath Dohrn; the further support which the Bureau will receive consists in part in the establishment of sub-bureaus at the expense of the nations concerned, *i. e.*,—Russia, Poland—in part in the voting of money grants towards the maintenance of the central Bureau: *e. g.*, the Swiss Federal Board of Education, the cantonal and town Boards of Zürich, a subscription under the 'Sociétié Zoologique de France.' In this country a subscription of $250 in addition to what has already been secured is all that is asked for. It does not seem too much to expect that this sum can be raised in the country as a whole as soon as the learned societies meet again in the fall.

In conclusion, let me say a few words in regard to the relations of our undertaking to that of the Royal Society. The organization of the Zoölogical Bureau was already well under way and several committees had been appointed when the circular of the Royal Society came to hand. On receipt of this circular we at once made inquiry of the Secretary of the Society, Professor Foster, in regard to the probable attitude of the Royal Society towards our undertaking, and were assured that the Royal Society would certainly prefer to absorb, or make one with it, all existing enterprises, rather than to try to rival them with a new one. A more definite answer was at that time impossible, nor can it be given at present. It was, however, all that we could desire, for this was precisely the great difficulty of our task, viz.: that it involved too great personal sacrifices for it to be possible to count with certainty upon its being given us through long periods of time. The Bureau is therefore being organized provisionally for the period of 5 years, so that the work can then be continued under the auspices of the Royal Society, provided the Society succeeds in realizing its project. On the other hand, if the larger plan fails, then the Bureau must live on its own resources. This is surely a wiser course than to abandon the undertaking and make useless the

sacrifices already made; in any case the literature for the period from 1896 to 1900 will have been well indexed and an important experiment in view of the Royal Society's undertaking will have been tried.

I should like finally to remind authors and publishers that they can greatly aid in this work by preparing short *résumés* of their publications as recommended in these columns by Professor Bowditch.

HERBERT HAVILAND FIELD.

GREAT NECK, L. I., NEW YORK.*

## SCIENTIFIC LITERATURE.

*Le pêtrole, l'asphalte et le bitume, au pointe de vue geologique.* Par A. JACCARD, professor de geologie a l'académie de Neuchatel. Anceinne librarie Germer Bailliere et cie. Paris. 1895.

This work forms one of the volumes of the Bibliothéque Scientifique Internationale and has been published since the author's death, on the 5th of last January.

The task of reviewing the work of one no longer living imposes upon the reviewer great care that no injustice shall be done the author, either as regards his intention or accomplishment. A very careful perusal of the work has shown that the author was a very close observer of nature, and a man of very positive convictions within the range of his own observations, yet in his final conclusions not too confident of his own infallibility, although at times, along the line of argument that he maintains throughout the work, his language very closely approaches upon dogmatism. He devoted his life to the study of the geology of the Jura, and that portion of France and Switzerland which includes the celebrated deposits of bituminous limestone and sandstone lying in the upper valley of the Rhone, from Neuchatel to Pyrimont and beyond. In this work he has included, not only the results of his own observations, but those of many other writers from the earliest mention made in scientific literature to the present time. I do not question that in respect to this particular department of the general literature of bituminous substances, or, more properly speaking, of bitumen, that this work is without a rival the most complete that has been devoted to the scientific discussion of this subject.

I think it is to be regretted that the author attempted a more ambitious work, and sought to reach general conclusions that, beyond the horizon of his own observations, were based upon the work of others made at various dates and under various conditions, which M. Jaccard appears to have accepted without much discrimination. He further allowed himself to be confined exclusively to works written in the French language which, embracing, as they do, many of the most valuable original memoirs extant, would at the same time exclude all access to the original works of American, English and German writers on the subject. As an illustration he quotes at this date (1895) the conclusions reached by M. Daubré in his 'Rapport du jury de l'exposition internationale de Paris, 1867,' in relation to the petroleums of North America. This paucity of information written in the French language, and injudicious use of French authors who have discussed the subject second hand, renders the work of very little value so far as it relates to American bitumen.

Again, he devotes a considerable portion of the work to the discussion of the 'Origin of Bitumen,' a subject that cannot be discussed from the 'point of view' of geology alone, as it involves a knowledge of both the chemistry and technology of bituminous substances. The apparent lack of knowledge of the details of the chemistry and technology of bitumens has led to many misstatements and invalid conclu-

* Address after September 3d, care of Brown, Shipley & Co., London, E. C.

sions throughout the work. To cite these instances in detail would require too much space, but they will not fail to arrest the attention of those familiar with the subject. It is no doubt to the same fundamental cause that the work owes its grave defects in classification, a defect that appears even in the title. Bitumen is the generic term that includes all forms of petroleum and asphalt. Moreover, no distinction is made between the peculiar use made by French authors of the word *asphalte* as applied to the asphaltic limestones and sandstones of eastern France and Switzerland and the use of the word to designate the solid form of bitumen, in which latter use he has made it the equivalent of 'asphalt' in English. The words naphtha and petroleum, and petroleum and maltha, are also used interchangeably to some extent in some places and with different meanings in others, so that throughout the work the use of these words is not clear. This confusion arises from a disregard of details that belong to chemistry rather than to geology.

As a whole, the work possesses great merits and grave defects; especially is the latter statement true in relation to American bitumen. The work should be read with careful discrimination, which is much to be regretted, as it will doubtless be widely read in Europe, where its merits will be much more apparent than its defects. S. F. PECKHAM.

*The Glacial Nightmare and the Flood.* By SIR HENRY HOWARTH, K. C. I. E., M. P., F. G. S., etc. 2 vols. Pp. 11–920. Sampson, Low, Marston & Co.

This volume is a manual of the facts and changing opinions gathered and expressed by the students of the superficial features of Europe and America from the earliest days of observation, and brings into prominence the names of many excellent men formerly overlooked or forgotten. The work is a fair history of the rise and decay of the theory of floods, of the universality and restriction of iceberg action, of the origin and culmination of the glacial theory. Thus far the author's views are only seen in the title. On the subject of the unity of the glacial period, the evidence is stated with the writer's judgment favoring one general period of cold. The astronomical theory of the cause of the Ice Age is shown to be unsustained by the evidence. The cause of glacial motion and the mechanical effects of the glaciers are discussed in a masterly manner, with conclusions very acceptable to most of us. The use of the doctrine of an ice cap and its subsequent restriction to continental areas is explained. But now the work is directed against extreme views, which have prevailed or are still dominant, on the ground of want of evidence. In the latter part of the work the writer ceases to be the judicial historian and becomes the philosopher, and explains some phenomena of the drift, carefully analyzed, by an appeal to 'waves of translation,' a modification of the doctrine of catastrophies in contra-distinction to the ideas of extreme uniformity which often need modification. The work is invaluable to the American student on account of giving him access to many of the fathers of superficial geology, whose works are not ordinarily accessible. These works also show how much more had been done by the early observers than is credited to them by most modern writers, partly on account of facts becoming public property in course of time, and partly on account of the impossibility of doing justice to so many men at all times. Yet these men were the intellectual ancestors in the field of surface geology. Another lesson is taught that conclusions of many of the most distinguished writers have not withstood deeper research, and have been replaced by the views of others who in turn will pass behind the curtains of time. Yet the science was originated and devel-

oped by these early geniuses, who should still be honored. As a manual the work should be in the hands of every student of superficial geology, and must form one of his most valuable works of reference. In a great manner the conclusion of the author will be most acceptable. On other points, differences of opinion will prevail here as in the works of all other philosophic writers. The title of the book is its sensational feature, and might awaken more opposition than its general judicial character would give rise to.

J. W. SPENCER.

*The Etiology of Osseous Deformities of the Head, Face, Jaws and Teeth.* By EUGENE S. TALBOT, M. D., D. D. S. Third Edition. Revised and enlarged, with 461 illustrations. Chicago, The W. T. Keener Company. Pp. 487.

Dr. Talbot's work is a most ambitious one, and this is perhaps its chief fault. It contains an enormous amount of facts and figures gathered from every source and touching upon every question from anthropology and crime to the useful art of taking care of the teeth. If the doctor could have condensed his book and given it a little more proportion and coherence it would appeal much more to the general and scientific reader. As it is, we find in it much original observation and a multitude of anatomical and anthropological facts which are interesting and should prove useful.

An excellent example of the author's work is shown in his chapter on developmental resources. Here he starts with the simple problem of the palatal arch in idiots and ends in a discussion of the general problem of osseous deformities as related to the different forms of degeneration. Dr. Talbot is manifestly a follower of Morel and Lombroso and adds many facts in support of the view that characteristic stigmata accompany the degenerative state. We must add again, however, that he fails to take what we would consider a properly conservative view of the question, and, while he gives many valuable data regarding criminals, he does not, we think, consider sufficiently the anatomy of the normal man of the low social stratum from which most of his criminals come. Lombroso has himself abandoned anthropometrical measurements as affording much help in establishing a criminal type.

We must add, in conclusion, and in justice to Dr. Talbot, that we know of no American who has made so many personal observations and measurements on the defective classes, and he is entitled to great credit for his work.

CHARLES L. DANA.

DOUBLE REFRACTION IN WOOD.

*Doppelbrechung electrischer Strahlen.* K. MACK. Wied. Ann. 54, 1895, p. 342.

*Bemerkung über die Abhandlung von Herrn Mack.* W. VON BEZOLD. Ibid. 54, 1895, p. 752.

*Doppelbrechung electrischer Strahlen.* A. RIGHI. Ibid. 55, 1895, p. 389.

Mr. Mack's article describes an interesting series of experiments to demonstrate that plates of wood exhibit a double refraction of electric waves. The sender and receiver were so arranged, with spark gap and reflectors, that the waves were 50–60 cm. in length. The test for double refraction in light is the lightening up of the field when the substance is introduced between crossed Nicols; similarly, Mr. Mack tested for double refraction of electric waves by introducing plates of wood between crossed sender and receiver. The first plates were of fir-tree 0,5-1,0 sq. M. area and 2,3 cm. thick, and gave negative results. An octagonal plate of fir about 60 cm. in diameter and 20 cm. thick was afterward used, and showed a decided double refraction when its fibres were 45° to the sender and receiver, and also between parallel sender and receiver showed

greater absorption when its fibres were parallel than when they were perpendicular to the plane of the vibrations. That is, the wood is double refracting and transmits best when the plane of vibration is perpendicular to the direction of the fibres and absorbs most when they are parallel. In fact, to this absorption the author ascribes the reappearance of the sparks with the crossed sender and receiver, since the plates of wood were not thick enough to give a retardation of one ray behind the other equivalent to a half wave-length; in fact, the plates were only from $\frac{1}{6}$ to $\frac{1}{2}$ a wave-length thick. The phenomenon was observed with plates up to 35 cm. thick and of fir, oak and beech. Plates cut perpendicular to the fibre showed no double refraction as was anticipated. The author refers to the experiments of Starkl showing that the thermal conductivity of wood is different, parallel with and perpendicular to the fibre.

W. von Bezold calls attention to the experiments on thermal conductivity by Tyndall, which led him in 1871 to experiment upon the Lichtenberg figures formed upon wood. At that time von Bezold found that the Lichtenberg figures on plates of wood cut with the grain fibre were elliptical with the major axis at right angles to the fibre, while the ellipses obtained upon the same wood by Senarmont's methed of testing thermal conductivity were much more elongated and in the direction of the fibre. The author was able to give to a hard rubber plate an anisotropic character by pasting parallel strips of tinfoil upon the back, whereupon it gave Lichtenberg figures similar to those on a piece of wood cut with the grain. He suggests experiments with a dielectric in which are imbedded rods of a conductor or a dielectric of different inductive capacity.

A. Righi points out that he had presented a paper before the Academy of Sciences at Bologna, which Mr. Mack evidently had not seen, although it was read nearly six months before his article appeared. On that occasion Mr. Righi described experiments similar to those of Mack, wherein he obtained identical results, even identifying elliptical and circular polarization in wood.

In conclusion, I may state that I have recently examined thin films of wood between crossed Nicols, using sunlight, and found in all cases the behavior toward light the same as that described for electric waves, albeit, one sees that the double refraction is not shared equally by all the components of the wood.

WILLIAM HALLOCK.

*Distribution of the Magnetic Declination in Alaska and Adjacent Waters for the Year 1895.* Bull. No. 34, U. S. Coast and Geodetic Survey. 8°, 6 pp. and 1 chart.

The above is a brief abstract of a fuller report to be published later by C. A. Schott, Assistant. As the title indicates, the paper attempts to give the latest representation of the distribution of the magnetic declination for the region indicated. It hence replaces the earlier (1890) attempt and gives evidence of a decided improvement. On account of the wide extent of the region involved and the paucity and irregular distribution of the observations, the analytical method of representing the available declinations was adopted. The formula established gives a very satisfactory accord with the observations covering a territory from 47°.4 to 71°.3 N and from 122°.4 to 156°.5 W of Gr. The largest discrepancy between the observed and computed declination is but 0°.9; the probable error of a single representation, ±19′.

On the chart the isogonics or lines of equal magnetic declination, as obtained with the aid of the formula, are given at intervals of one degree for the region covered by the above title.

L. A. BAUER.